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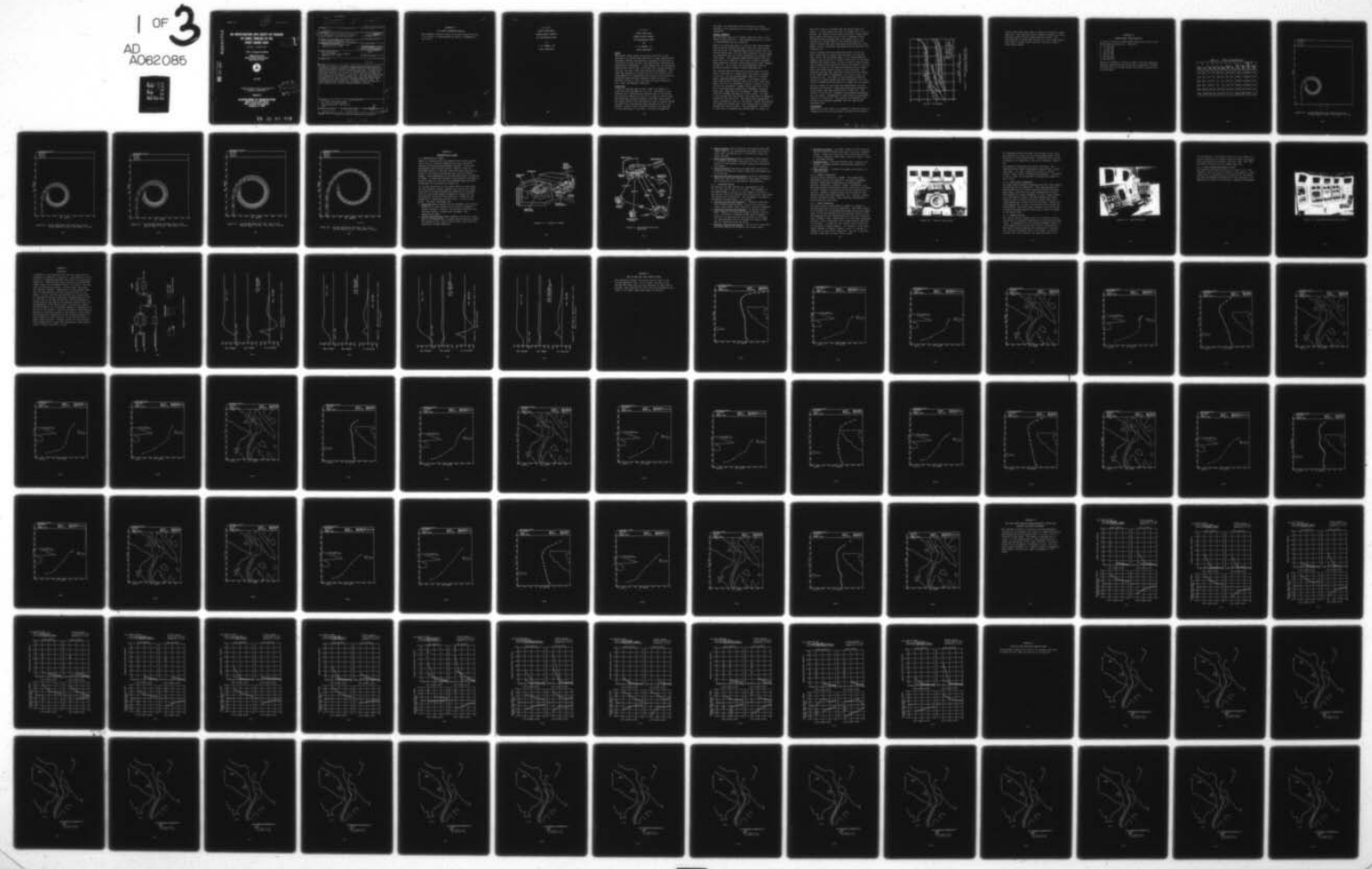


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Report No.

Vol. 2 of 2

AN INVESTIGATION INTO SAFETY OF PASSAGE OF LARGE TANKERS IN THE PUGET SOUND AREA

VOLUME II: APPENDICES

J. Riek, S. Tenenbaum, W. McIlroy

CAORF Research Staff
National Maritime Research Center
Kings Point, NY 11024

July 1978

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16. Abstract

A study was conducted at the Computer Aided Operations Research Facility to investigate the safety of passage of tankers through the Puget Sound area under maximum credible adverse environmental conditions. The study was conducted in two phases: off-line, using a computer program to simulate the performance of various size tankers, and on-line utilizing the CAORF simulator with human test subjects. In each phase, there were two types of runs: track keeping runs, and failed equipment runs. The track keeping results indicated that all ships were able to navigate safely under the extreme environmental conditions provided they maintained sufficient speed. The failed equipment runs indicated that tug support of ships was required to avoid grounding after suffering steering/propulsion failures.

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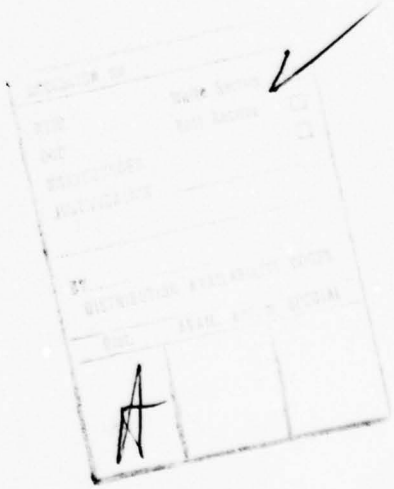
APPENDIX A

TUG FORCE REFERENCE MATERIAL

This appendix contains a copy of the data submitted by Mr. C. R. Horton, an acknowledged tug expert recommended by the U.S.C.G.



C.A.O.R.F.

PUGET SOUND AREA

TANKER SAFETY PROJECT

TUG ASSISTANCE STUDY

by

C. R. HORTON, JR.

NAVAL ARCHITECT

C.A.O.R.F.

PUGET SOUND AREA

TANKER SAFETY PROJECT

TUG ASSISTANCE STUDY

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NAVAL ARCHITECT

SCOPE

The subject study covers the potential ability of tug assistance to provide safe operation of large tankers while entering, leaving, and docking at terminals in the area of the Straits of Juan de Fuca, and Puget Sound, Anacortes and Cherry Point, Washington. It was agreed that the preferable system would involve use of the tugs that already operate in the area, but that other types should be considered. This study was required to furnish data for both, based on the requirements for stopping and controlling a ship having tug assistance when the ship suffered a power failure or a steering failure or both, and under the most adverse current, wind, and weather conditions.

CONDITIONS

A list of existing tugs by type, power, and method of propulsion was furnished by C.A.O.R.F. Discussion of the problem led to narrowing the required data to the forces that could be applied to the ship by tugs of various types and power when already attached to the ship under escort. The forces should cover the expected range of speeds through the water for a ship maintaining steering control in the channel, current, wind, and water depths to be expected, not the free speed of the ship. Six knots through the

the water, or three knots over the bottom in either adverse or fair currents up to six knots were considered reasonable.

GENERAL COMMENTS

The available tugs are of several types and cover a wide range of power and pull. Some explanatory notes will help in understanding the data supplied.

None of the existing tugs is a tractor type, which modern practice would consider the best choice for these duties. Data given for the flanking rudder astern nozzle type, the Z drive nozzle type, and the Voith-Schneider tractor types are therefore only for future construction or charter from other areas. The flanking rudder-astern nozzle type has been built up to 6000 H.P. and is not limited in maximum power except by available lines and bitts on ships, perhaps 10,000 H.P. The Z drive and Voith-Schneider tugs are believed limited in power to about 4000-5000 H.P.

The existing tugs can operate as attached escort tractor tugs at the stern of a large ship, with hawser attached at the bow, over the desired speed range up to 10 knots ahead, assuming adequate hawsers. In stopping a ship, these tugs can pull directly astern only until near zero speed, and if it is necessary to exert a lateral force on the ship to counteract a rudder failed hard over or the bias of backing ship's propeller in emergency stopping conditions, they would not be adequate. When creating stern way through the water in a fair current, in order to stop a ship over the bottom, they would have to change to towing over the tug stern. This would take considerable time to accomplish, say 8 to 10 minutes, unless the existing bow hawser was already led to the riding ring or sling was arranged for quick release. This arrangement is similar to that used on seagoing push towing tugs in a notch, so

that they can go on a hawser when the weather gets too severe. It would reduce the time for change over to 2 to 3 minutes, but requires very careful handling at high forward ship's speed, and would only be done at perhaps 3 knots through the water maximum due to the danger and to the limitation of astern speed on the existing tugs due to lack of control when they were being towed astern of their hawser, as well as weather considerations and generally low freeboard aft.

After reversing the tug as described above, and as the ship's speed went to astern and increased, the existing tugs, and in fact any known type of tug, would gradually largely lose its ability to exert lateral force on the ship combined with astern force, so that at about 8 knots astern only a nearly direct astern pull would be possible, and the degree of control of the ship would depend on the current, wind, and failed rudder or ship's forces existing. The reversed existing tugs, especially those with Kort nozzles, would, under these circumstances, do as well as any, but at greater risk. All types of tug propulsion gradually lose pull as speed through the water increases, or as the control elements produce forces at an angle with the hawser.

Several studies of tug forces and requirements for safe handling and docking of large ships have been conducted in recent years, and some current work is under way. The studies of the British, Japanese, and Canadian governments are very useful, and Marad/U.S. Coast Guard are performing tests on a Z drive tug. The results are reasonably consistent and in general agreement with the conclusions expressed here.

CONCLUSIONS

Figure A-1 of this report is intended to show the astern or stopping pull which the existing tug types and alternative

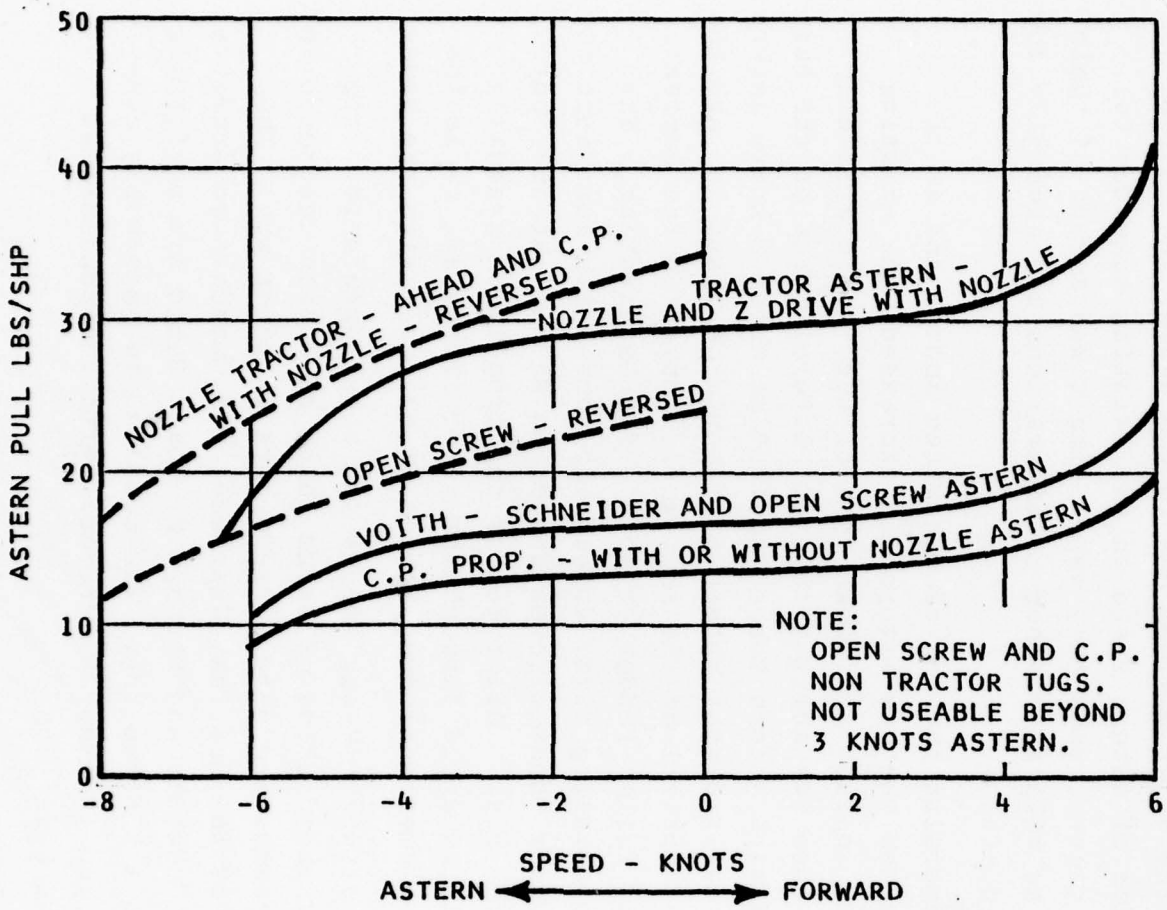


Figure A-1. CAORF Study Tug Stopping Pull
(Use 80% for Actual Pull).

tractor tugs could exert when in position following a tanker under way. The tugs would have a hawser attached at the bow and would exert the pulls shown directly astern. The existing tugs of either open screwn, C.P. with rudder nozzle, twin screw or single screw, would be limited to about 3 knots astern speed.

APPENDIX B

TANKER MODEL CHARACTERISTICS

A total of six fully loaded tanker models were used in the Puget Sound investigation. They were:

- 40,000 DWT
- 80,000 DWT
- 120,000 DWT
- 165,000 DWT
- 280,000 DWT
- 400,000 DWT

Table B-1 contains a listing of some of the more important physical characteristics of each ship; Figures B-1 through B-5 show the plot of high speed, hard right turning circle for each ship.

TABLE B-1. VESSEL CHARACTERISTICS

Vessel Type	Lpp (ft)	Beam (ft)	Depth (ft)	Draft (ft)	Block Coeff	Prop. Diam (ft)	Pitch (ft)	Displacement (tons)	Rudder Area (ft^2)	Wetted Hull Profile Area (ft^2)	Rudder Area Ratio
40K	597	90	49.5	36.9	0.77	19.03	13.06	43,618	396.5	22029.3	0.018
80K	763	125	59	39.9	0.8	23.0	18.4	86,982	517.5	30443.7	0.017
120K	850	145	67	47	0.8	26.5	21.3	142,852	747.8	43987.5	0.017
165K	951	155.4	71	52	0.81	26.0	19.6	180,550	746.3	49756.3	0.015
280K	1066.3	173.9	92.9	72.35	0.83	29.86	21.3	318,928	1388.7	77149.0	0.018
400K	1148.35	230.0	92.2	72.91	0.83	31.8	21.3	465,000	1590.8	83726.2	0.019

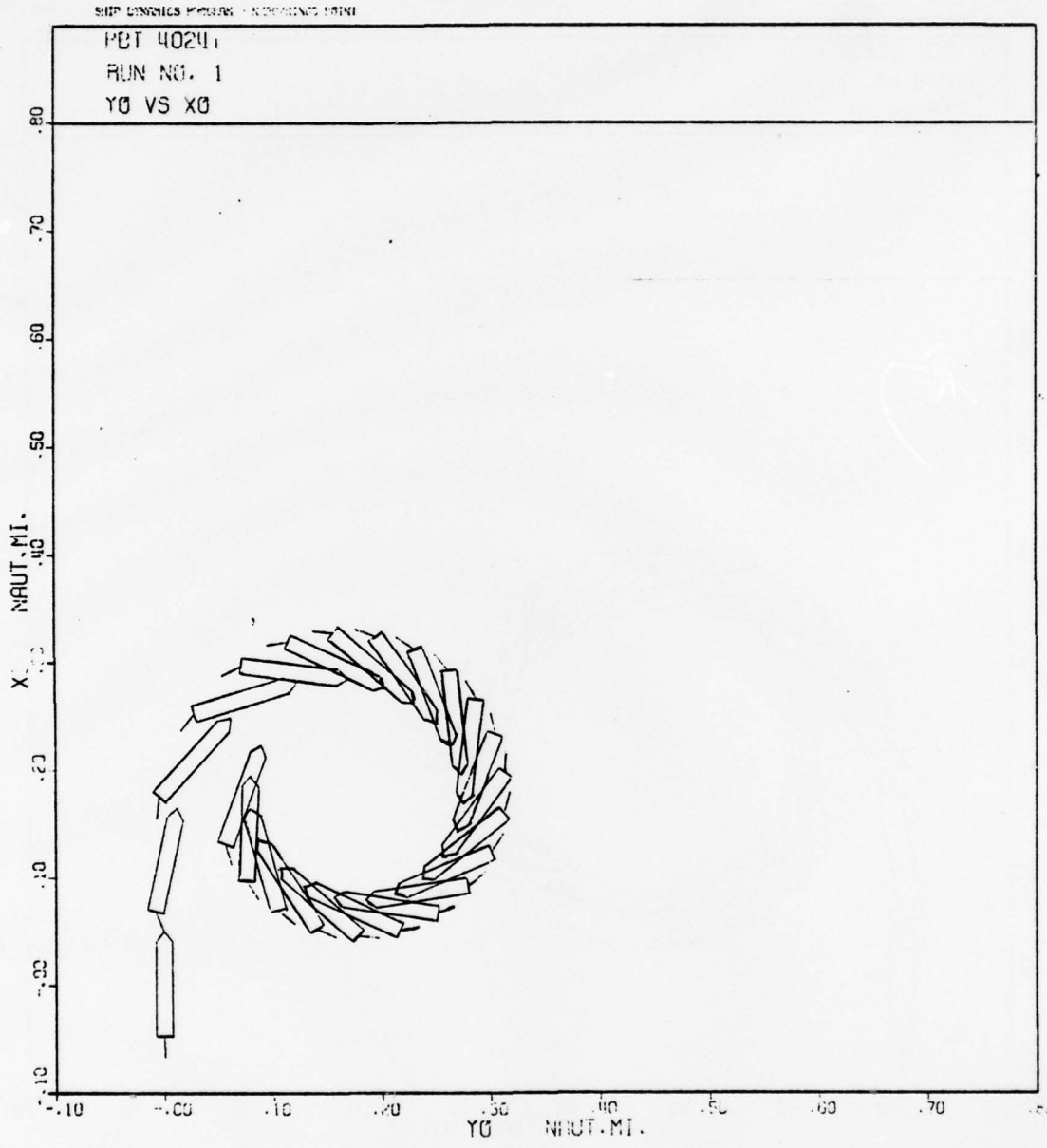


Figure B-1. 40,000 DWT Tanker 35° Right Turn Circle. Initial Speed = 14 kts. Plot Freq. = 30 sec.

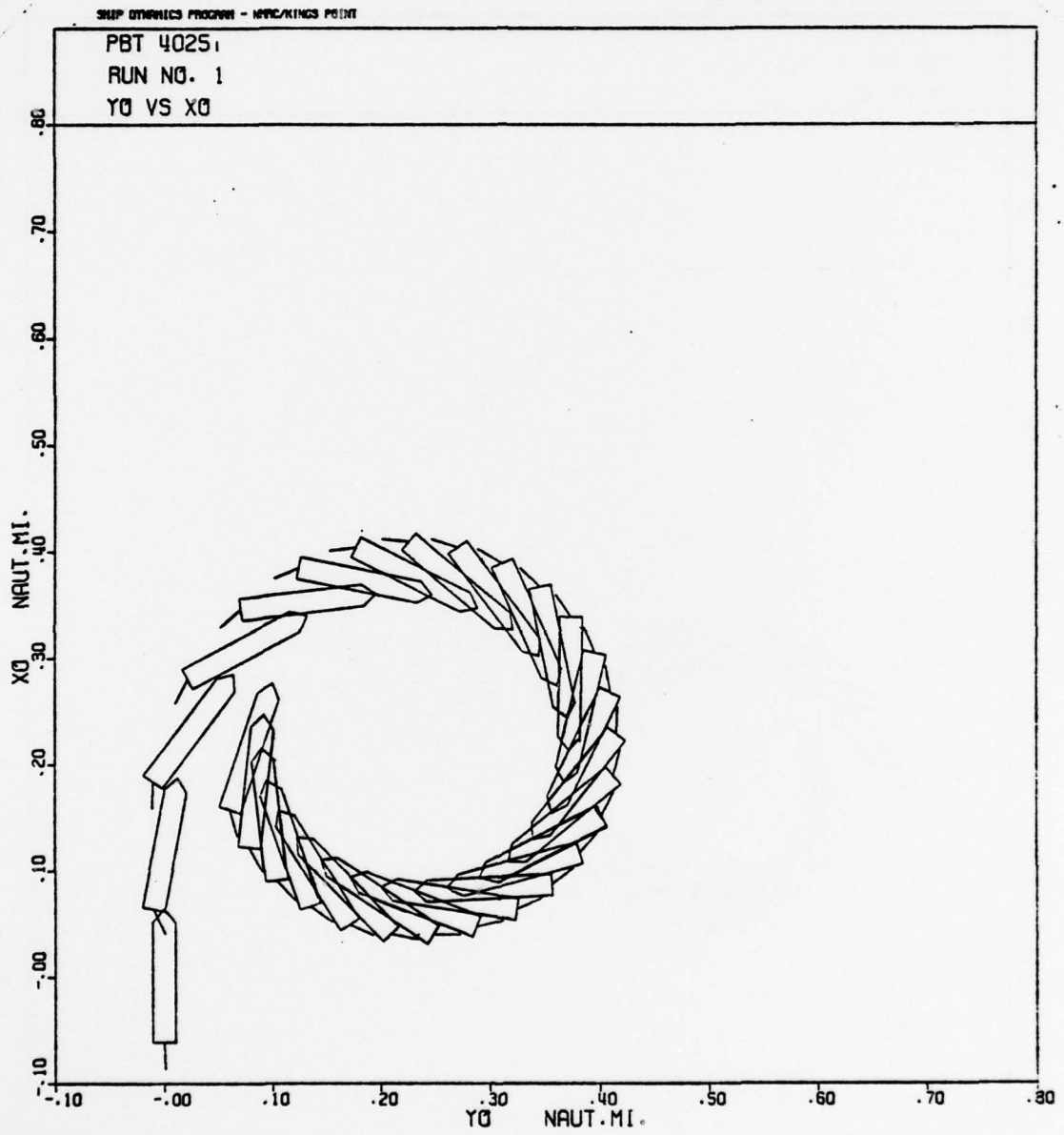


Figure B-2. 80,000 DWT Tanker 35° Right Turn Circle. Initial Speed = 15 kts. Plot Freq. = 30 sec.

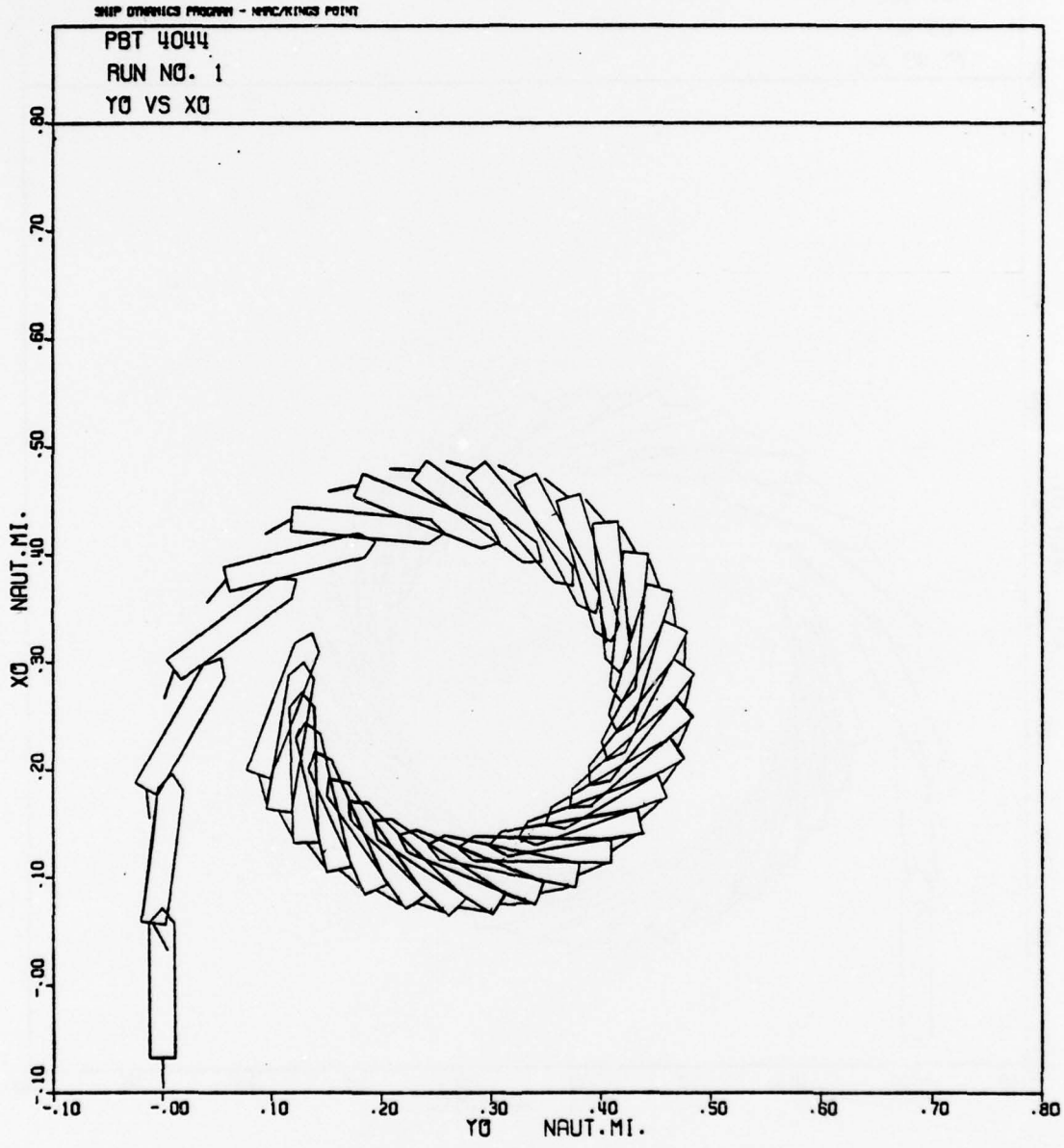


Figure B-3. 120,000 DWT Tanker 35° Right Turn Circle. Initial Speed = 15 kts. Plot Freq. = 30 sec.

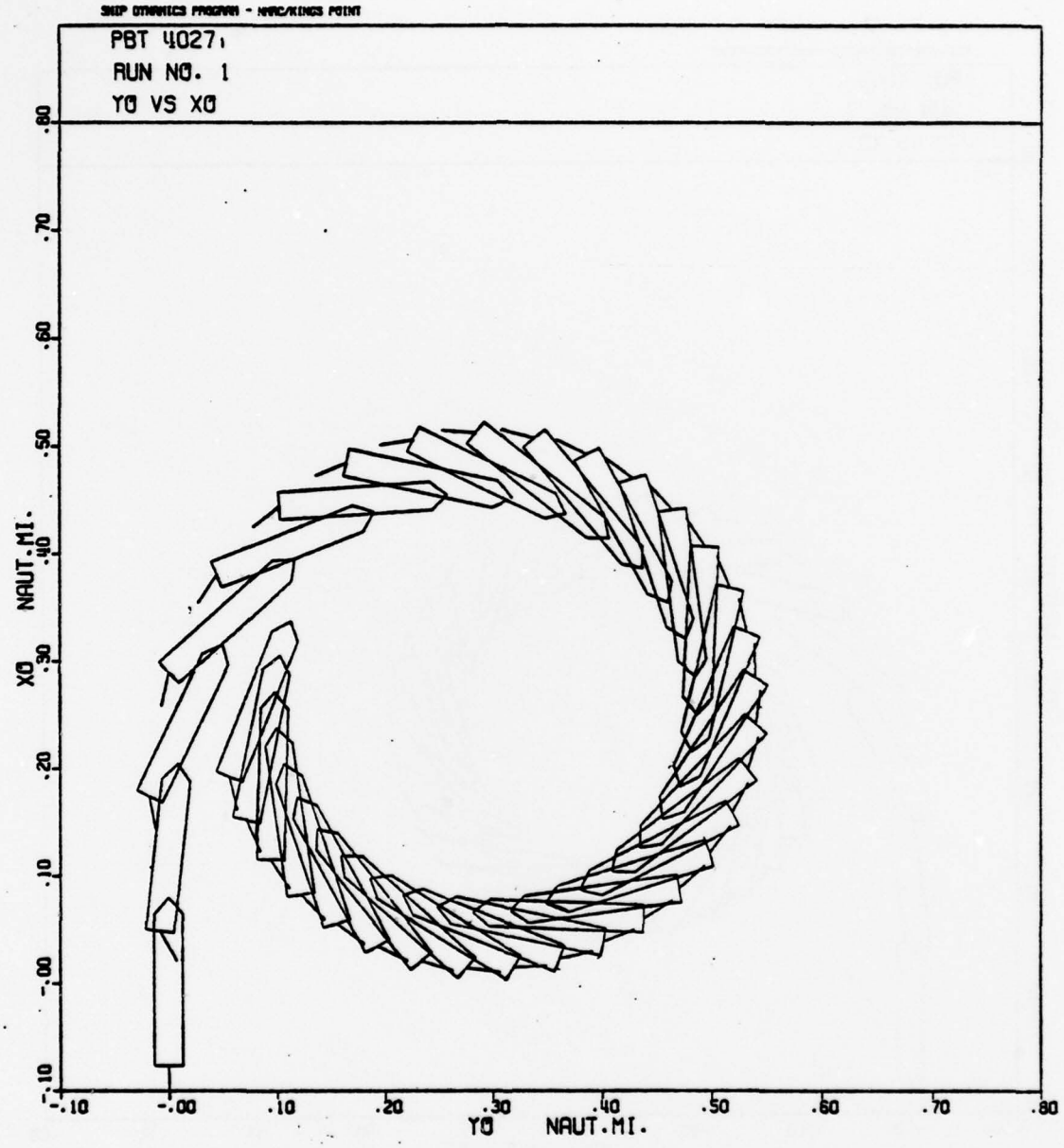


Figure B-4. 165,000 DWT Tanker 35° Right Turn Circle. Initial Speed = 15 kts. Plot Freq. = 30 sec.

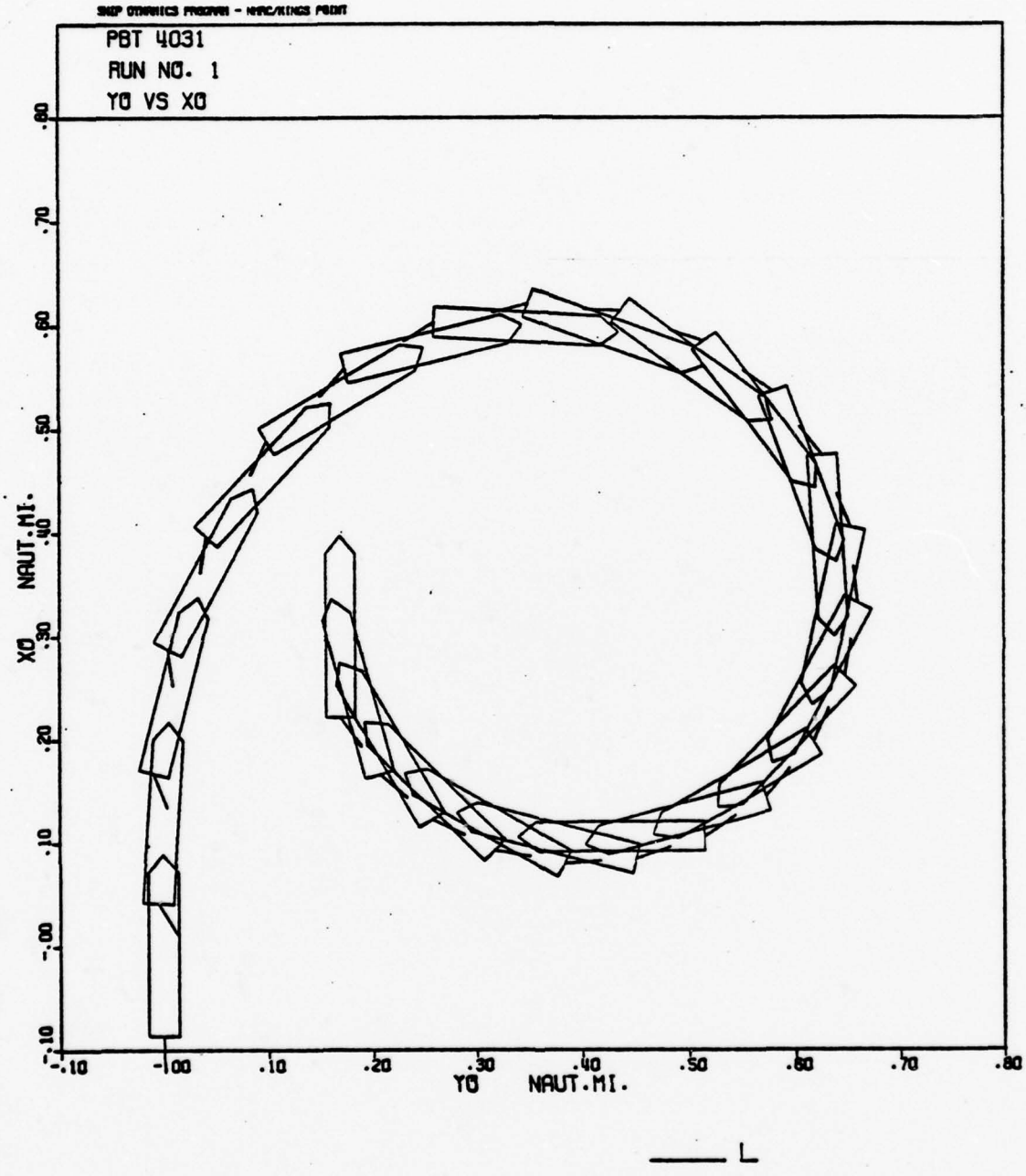


Figure B-5. 280,000 DWT Tanker 35° Right Turn Circle. Initial Speed = 15 kts. Plot Freq. = 30 sec.

APPENDIX C

DESCRIPTION OF CAORF

C-1 DESCRIPTION OF CAORF

CAORF is a sophisticated ship-maneuvering simulator operated by the U.S. Maritime Administration for controlled research into man-ship-environment problems. Controlled experiments, which require several vessels, cannot be performed readily in the real world and would certainly be ruled out for testing situations that involve potential danger. Such experiments can be performed safely and easily at CAORF. A simplified cutaway of the simulator building is shown in Figure C-1 and the relationships among the major subsystems are illustrated in Figure C-2.

All actions called for by the watch officer on the bridge are fed through a central computer that alters the visual scene and all bridge displays and repeaters in accordance with the calculated dynamic response of ownship and the environmental situation being simulated. CAORF has the capability of simulating any ship, port, or area in the world. The major subsystems are:

- Wheelhouse which contains all the equipment and controls needed by the test subject watch officer to maneuver ownship through a scenario, and includes propulsion and steering controls, navigational equipment, and communication gear
- Central Data Processor which computes the motion of ownship in accordance with its known characteristics, models the behavior of all other traffic ships, and drives the appropriate bridge indicators

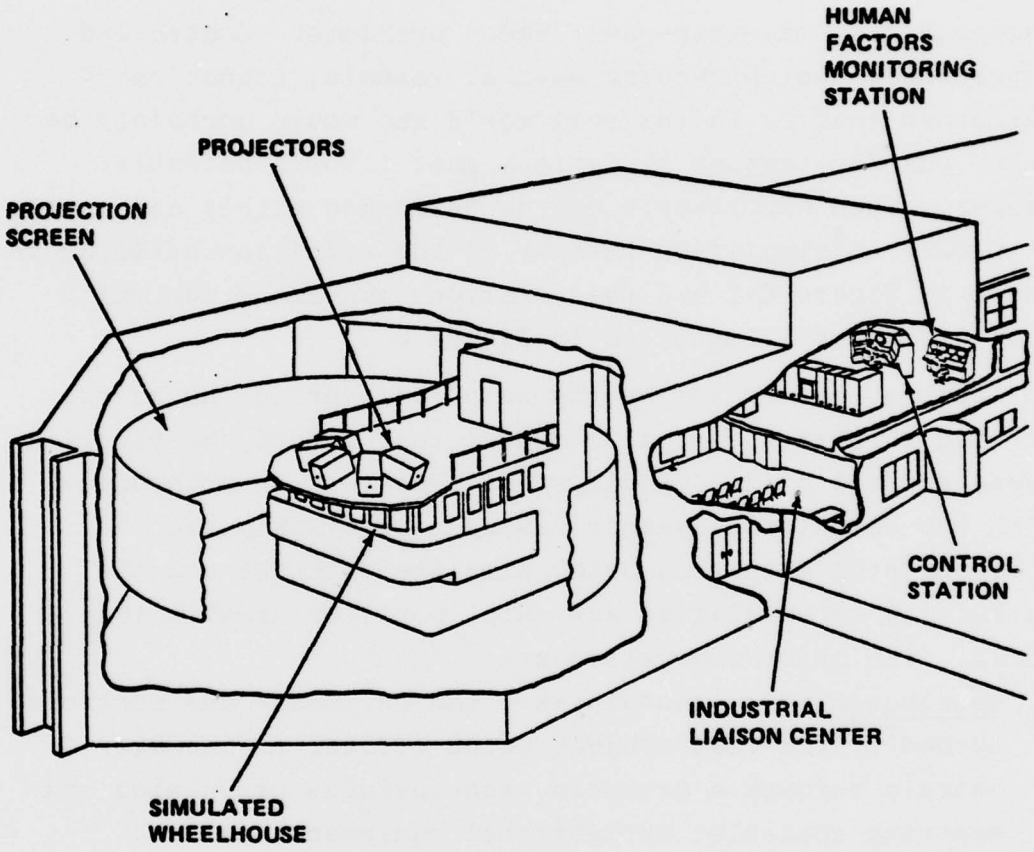


Figure C-1. Cutaway of CAORF.

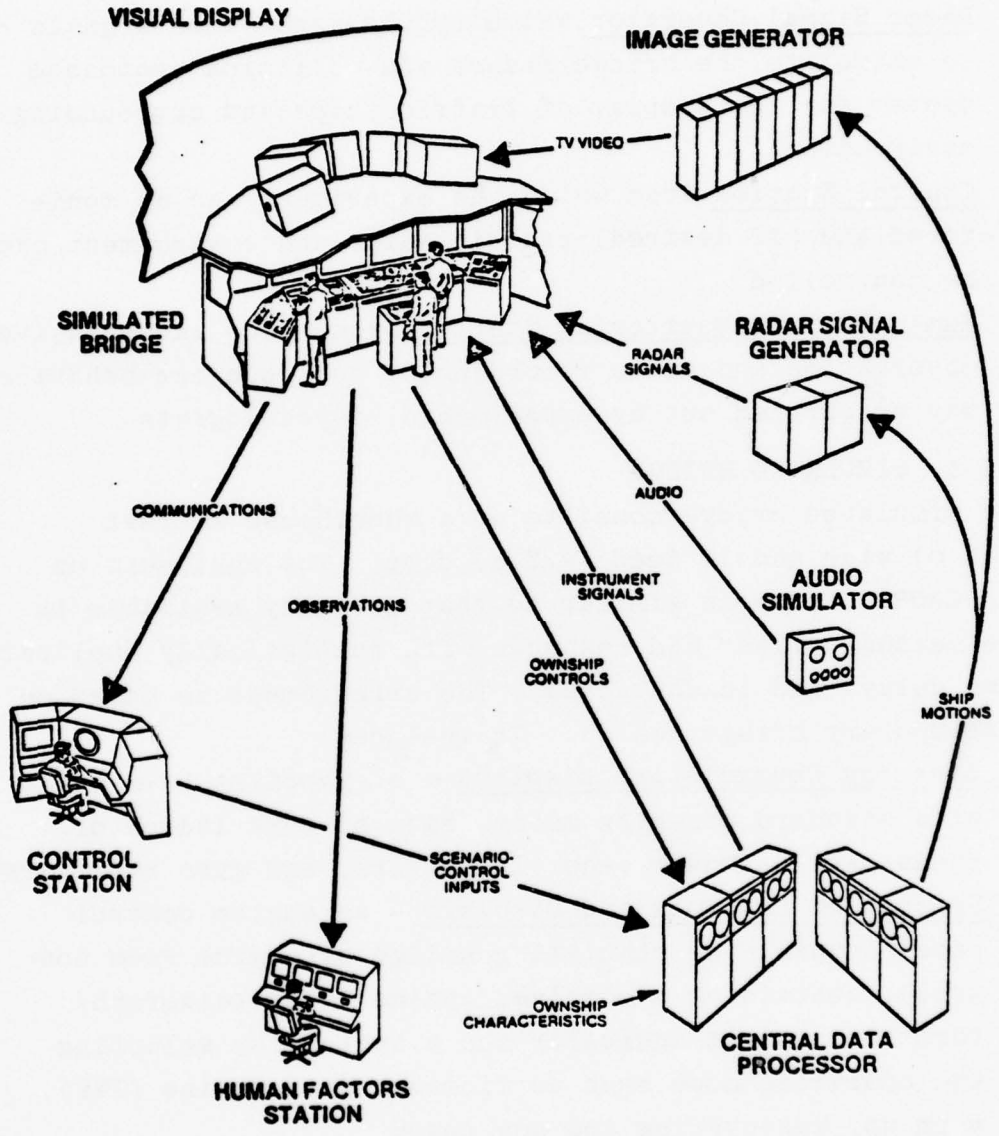


Figure C-2. Relationships Among Major Subsystems.

- Image Generator which constructs the computer-generated visual image of the surrounding environment and traffic ships that is projected onto a cylindrical screen for visual realism
- Radar Signal Generator which synthesizes video signals to stimulate the bridge radars and collision avoidance system for the display of traffic ships and surrounding environment
- Control Station from which the experiment can be monitored and (if desired) traffic ships and environment can be controlled
- Human Factors Monitoring Station from which unobstrusive observation and video recording of test subject behavior may be carried out by experimental psychologists

C.1.1 SIMULATED BRIDGE

The simulated bridge consists of a wheelhouse 20 feet (6.1 m) wide and 14 feet (4.3 m) deep. The equipment on the CAORF bridge is similar to that normally available in the merchant fleet and responds with realistically duplicated time delays and inaccuracies. The arrangement is based on contemporary bridge design. It includes:

- Steering Controls and Displays - a gryopilot helm unit with standard steering modes, rate of turn indicator, rudder angle/rudder order indicators, and gyro repeaters
- Propulsion Controls and Displays - an engine control panel (capable of simulating bridge or engine room control), containing a combined engine order telegraph/ throttle, an rpm indicator and a switch for selecting the operating mode such as finished with engine (FWE), warm up, maneuvering and sea speed
- Thruster Controls and Display - bow and stern thrusters and their respective indicators and status lights

- Navigation Systems - two radars capable of both relative and true motion presentations plus a collision avoidance system. Capability exists for future additions such as a digital fathometer, RDF (Radio Direction Finder), Loran C, and Omega systems
- Communications - simulated VHF/SSB radio, docking loudspeaker (talkback) system, sound powered phones and ship's whistle
- Wind Indicators - indicate true speed and direction of simulated wind.

C.1.2 OWNSHIP SIMULATION

Any ship may be simulated at CAORF. The computerized equations of motion are adapted to the ship by changing specific coefficients among which are hydrodynamics, inertial, propulsion, thruster, rudder, aerodynamic, etc. Wind and currents realistically affect ship motion according to draft (loaded or ballasted) and relative speed and direction. Ownship's computer model was validated by comparing various simulated maneuvers (e.g., zig-zag, turning circle, and spiral tests, crash stops and acceleration) with actual sea trial data.

C.1.3 IMAGE GENERATION

The visual scene is duplicated on CAORF to a degree of realism sufficient for valid simulation. The scene (Figure C-3) includes all the man-made structures and natural components of the surrounding scene that mariners familiar with the geographical area deem necessary as cues for navigation. Thus, bridges, buoys, lighthouses, tall buildings, mountains, glaciers, piers, coastlines, and islands would be depicted in the scene. In addition, the closest traffic ships and the forebody of ownship appear. All elements in the scene, except ownship's forebody, appear to move in response to ownship's and other ship's maneuvers. The sky is depicted without clouds and the water without waves.

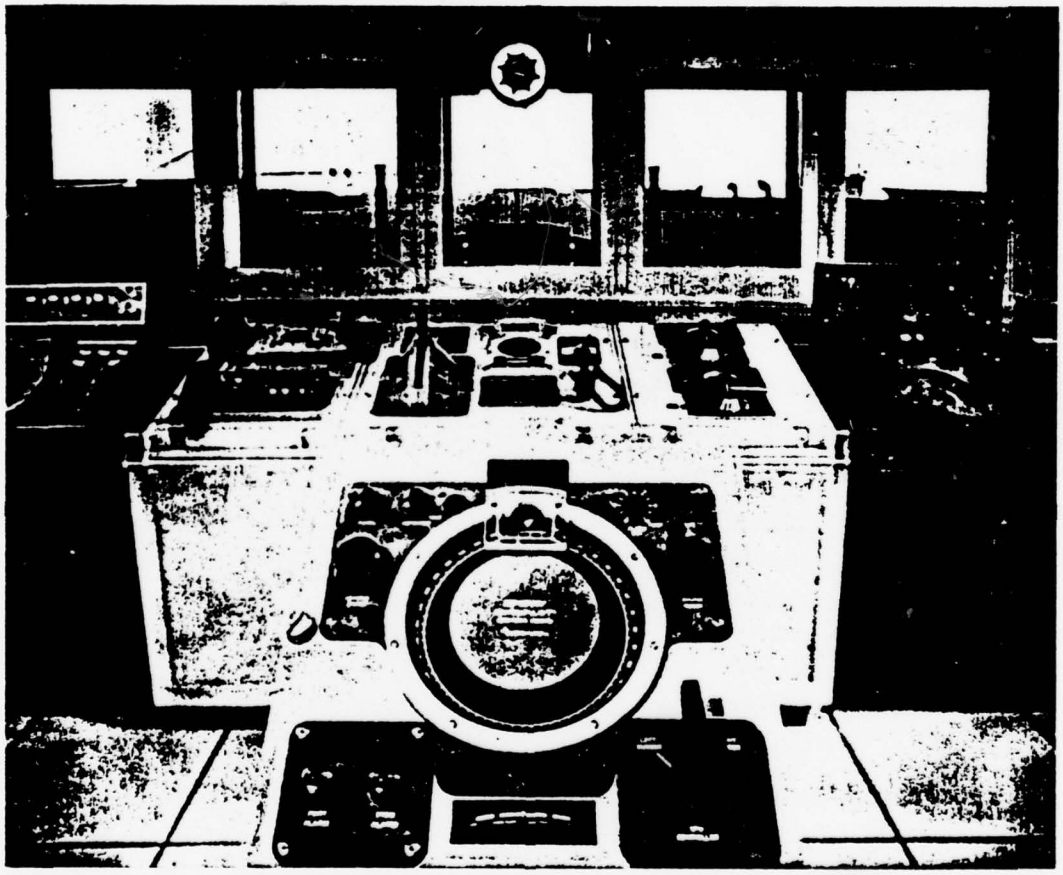


Figure C-3. Typical Visual Scene

For enhanced realism the scene is projected in full color. The perspective is set for the actual bridge height above waterline for the simulated ship. Shadowing can be varied according to the position of the sun at different times of day.

Environmental conditions also affect the scene. The lighting can be varied continuously from full sun to moonless night. At night, lights can be seen on traffic vessels, buoys, piers, and other points ashore. Visibility in day or night can be reduced to simulate any degree of fog or haze.

C.1.4 RADAR SIGNAL GENERATION

The Radar Signal Generator produces real-time video signals for driving the two radar PPIs. The items displayed are synchronized with the visual scene and include navigation aids, ships, shoreline and other topographical features with appropriate target shadowing, clutter, range attenuation, and receiver noise. The radar gaming area which covers an area of 150 by 200 miles, extends beyond the visual gaming area, which is 50 by 100 miles. Within the radar gaming area, as many as 40 moving traffic ships can be displayed. The radar signal generator also drives the collision avoidance system, which can be slaved to either of the master PPIs.

C.1.5 CONTROL STATION

The control station (Figure C-4) is the central location from which the simulator experiment is controlled and monitored. An experiment can be initiated anywhere within the visual gaming area with any ship traffic configuration. The control station enables the researchers to interfere with the watch-standing crew on the bridge, to simulate malfunctions, and to control the operating mode of the

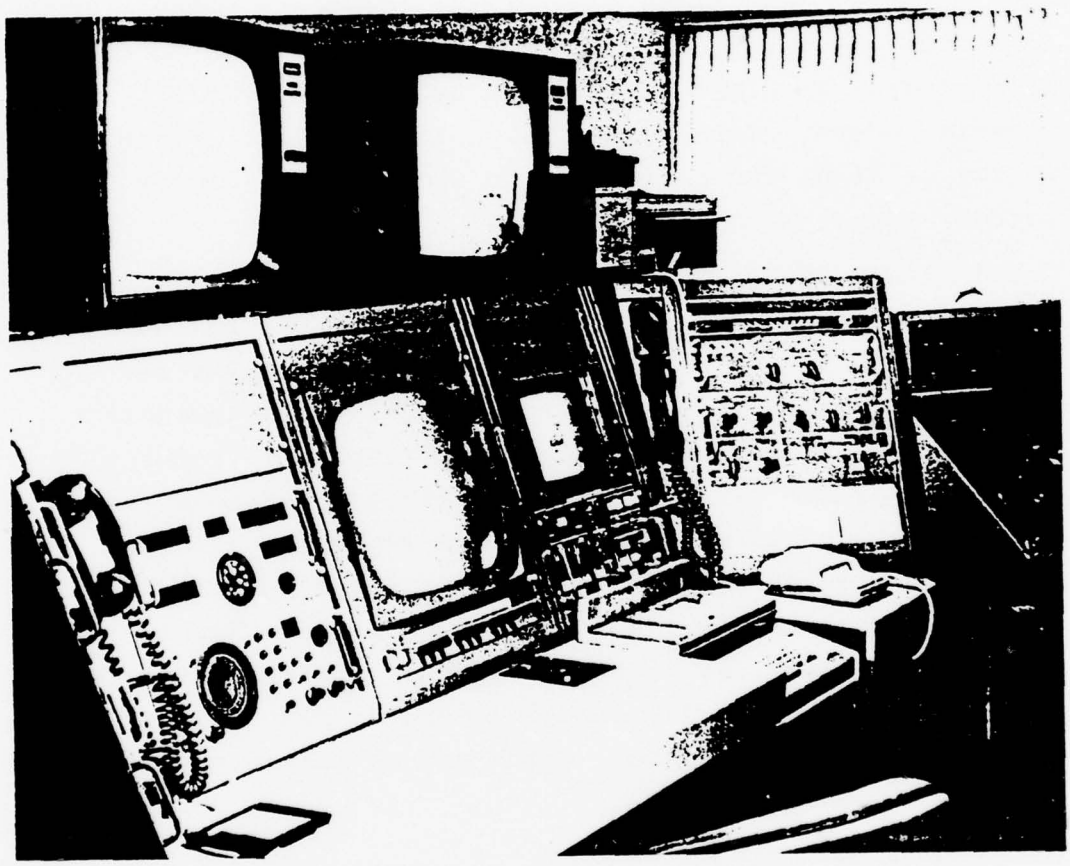


Figure C-4. Control Station

of the simulator. The Control Station is also capable of controlling motions of traffic ships and tugs in the gaming area and simulating telephone, intercom, radio (VHF, SSB) and whistle contact with the CAORF bridge crew.

C.1.6 HUMAN FACTORS MONITORING STATION

The Human Factors Monitoring Station (Figure C-5) is designed to allow collection of data on crew behavior. Monitoring data is provided by five closed-circuit TV cameras and four microphones strategically located throughout the wheelhouse to record all activities, comments and commands.

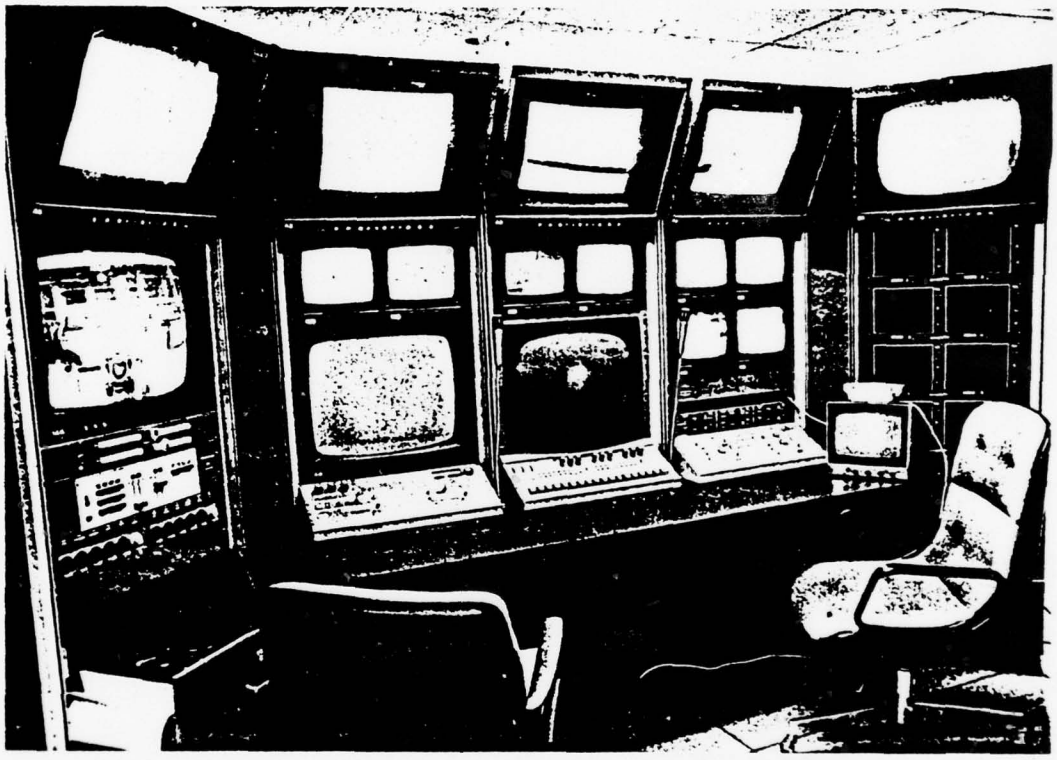
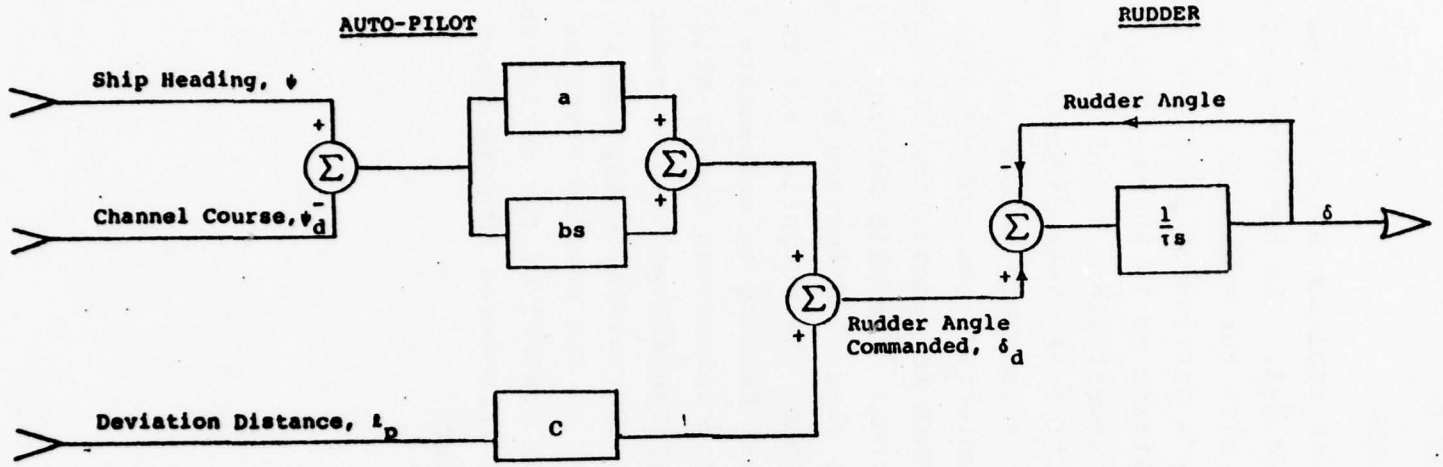


Figure C-5. Human Factors Monitoring Station.

APPENDIX D

AUTOPILOT

A schematic of the autopilot with typical values for the constants is presented in Figure D-1. The behavior of this autopilot in handling channels with turns is illustrated in Figure D-2. These figures show a portion of an 80,000 DWT tanker transit of the Rosario Strait at 10 knots. The four runs are no wind and current, current alone, wind alone, and wind with current. Examination of these figures shows that the ship executes the turn reasonably well in all cases. In fact, for the case selected, the current aids in reducing the deviation distance in negotiating the turn. For the case of no wind and current, the ship heading in steady state is the same as the channel direction with rudder amidships. With current alone, the autopilot steers the ship slightly off the channel heading to compensate for the set of the current. The wind introduces leeway which is handled in a realistic manner by the autopilot with rudder. The steady-state condition with the autopilot exposed to a cross current is a path parallel to the desired track at a small offset distance. Integral control of the deviation, after completion of a turn, was introduced in some cases in order to reduce the effect to zero.



Typical Values

a = a'	a' = 4	L = Ship Length
b = b' (L/u)	b' = 2	u = Ship Speed
c = c' (180/Lπ)	c' = 2	τ = Rudder Time Constant

Figure D-1. Autopilot Schematic.

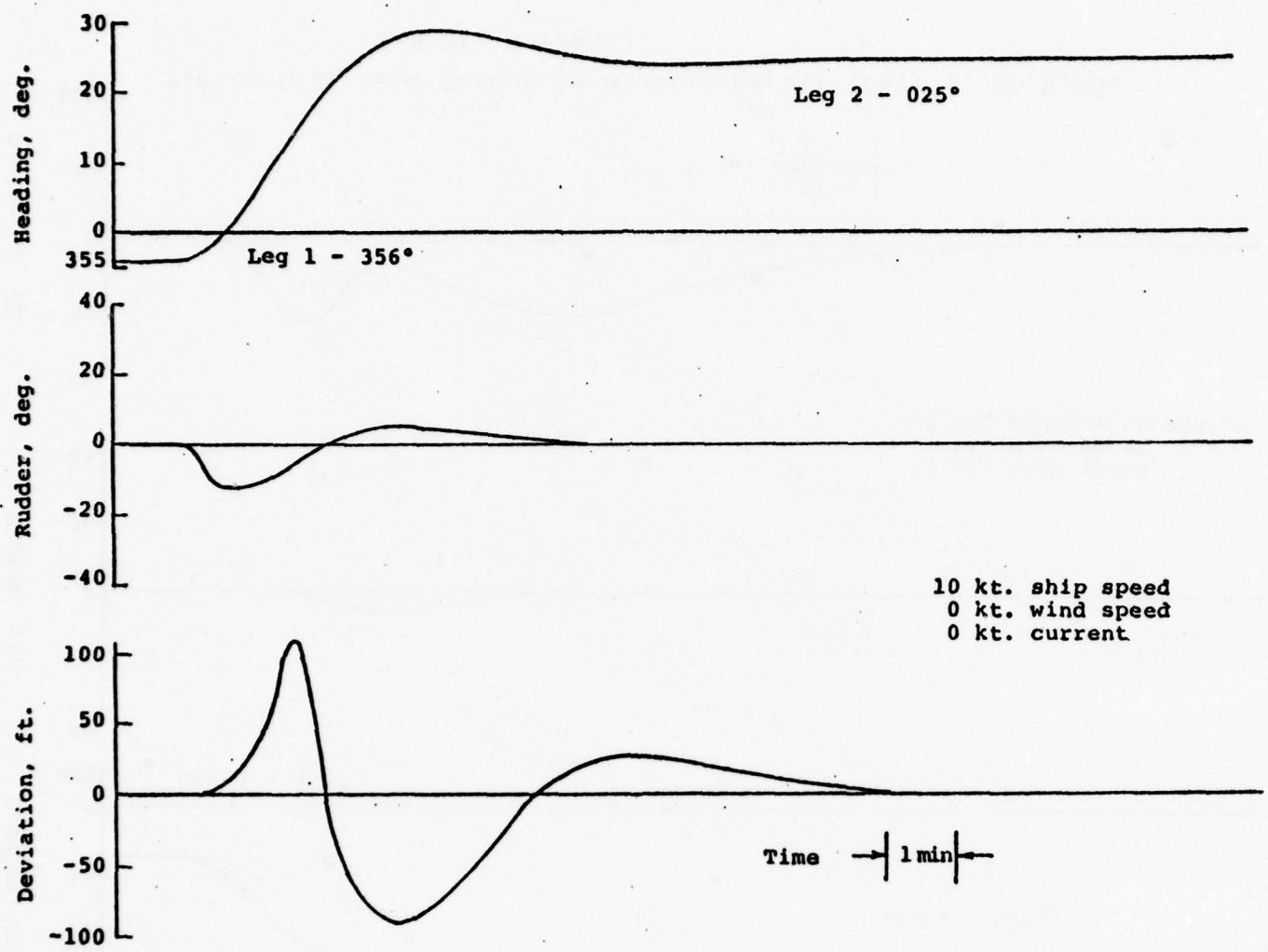


Figure D-2. 80K Tanker in Rosario Strait (Part 1, No Wind, No Current).

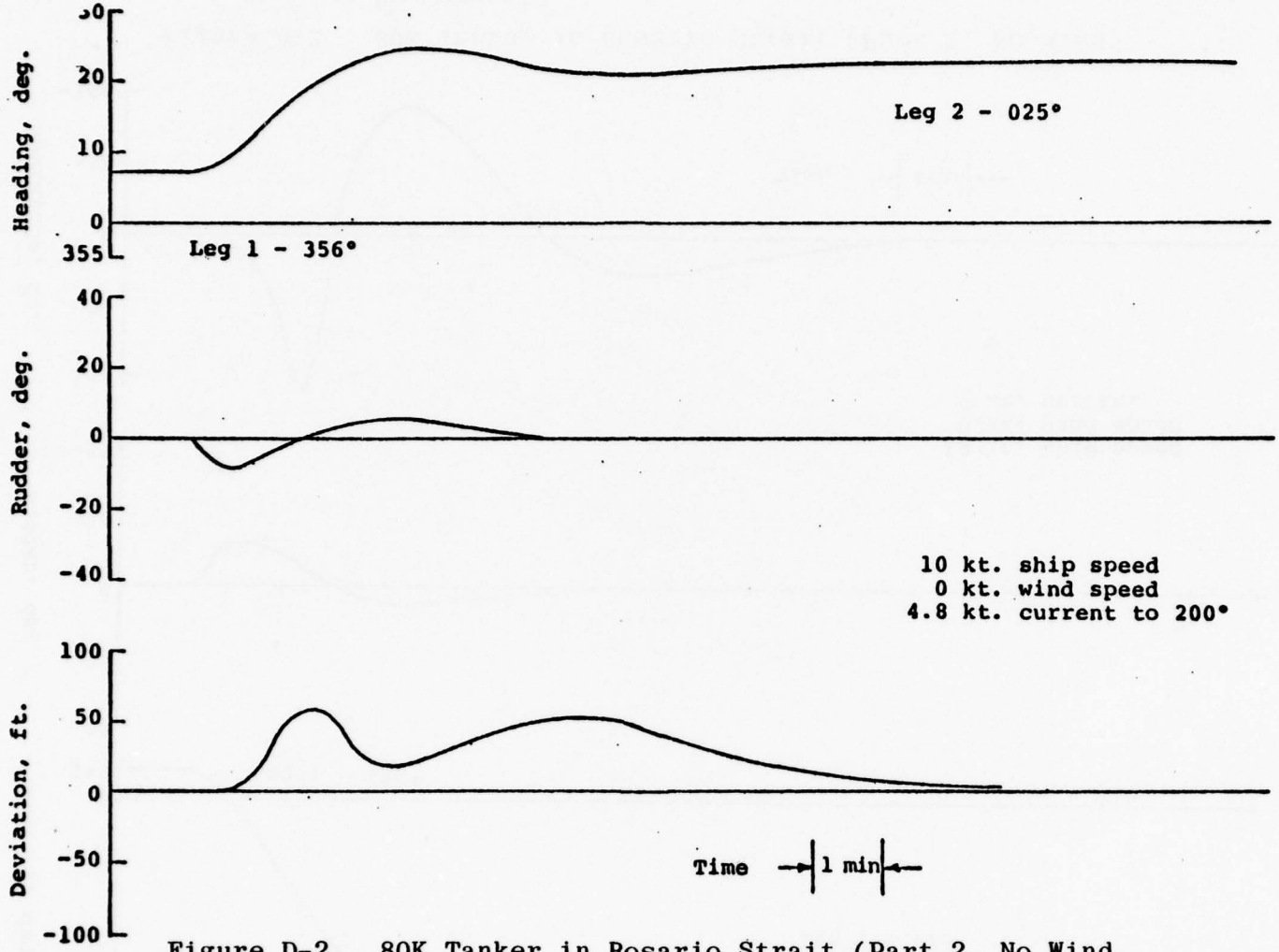


Figure D-2. 80K Tanker in Rosario Strait (Part 2, No Wind, 4.8 kt. Current).

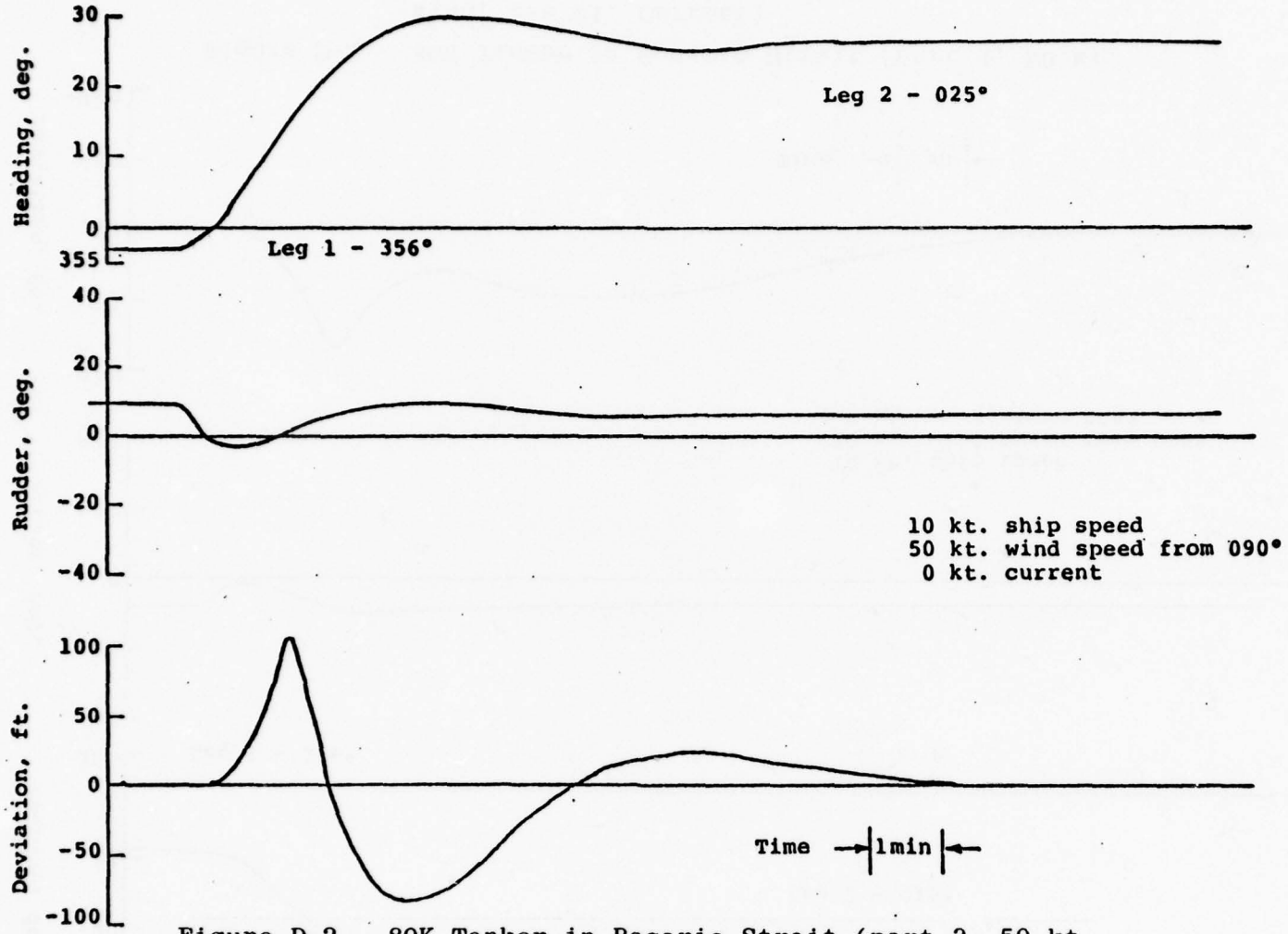


Figure D-2. 80K Tanker in Rosario Strait (part 3, 50 kt. Wind, No Current).

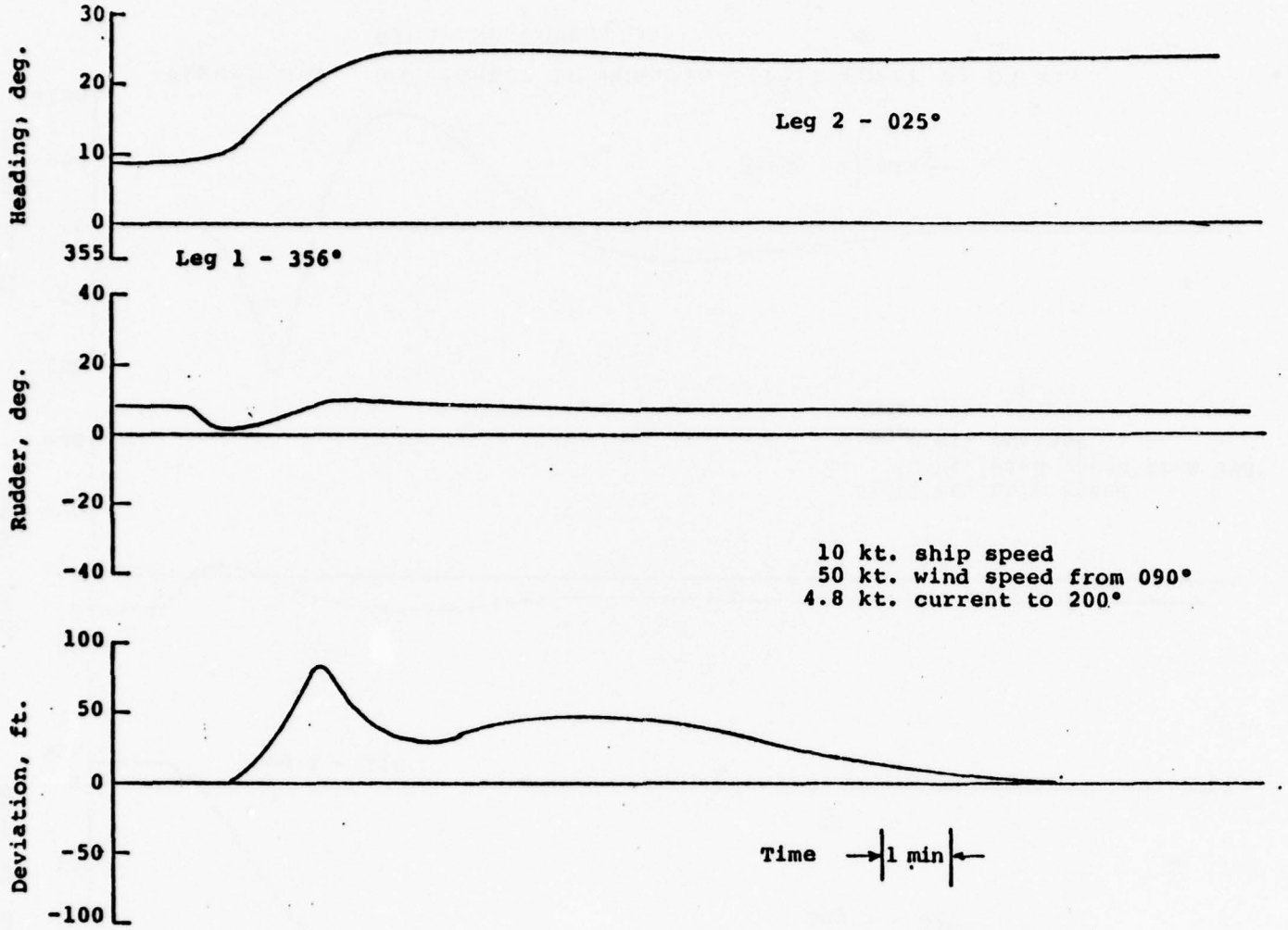
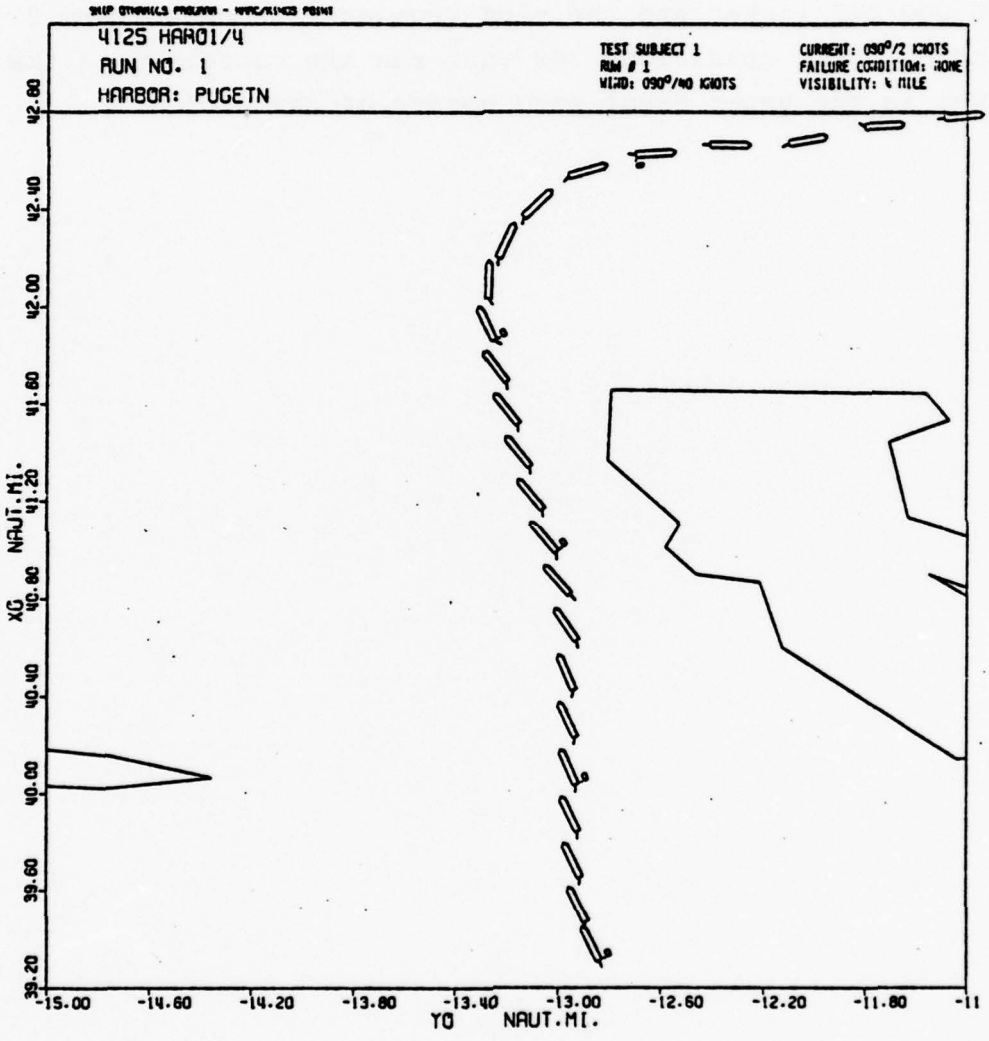


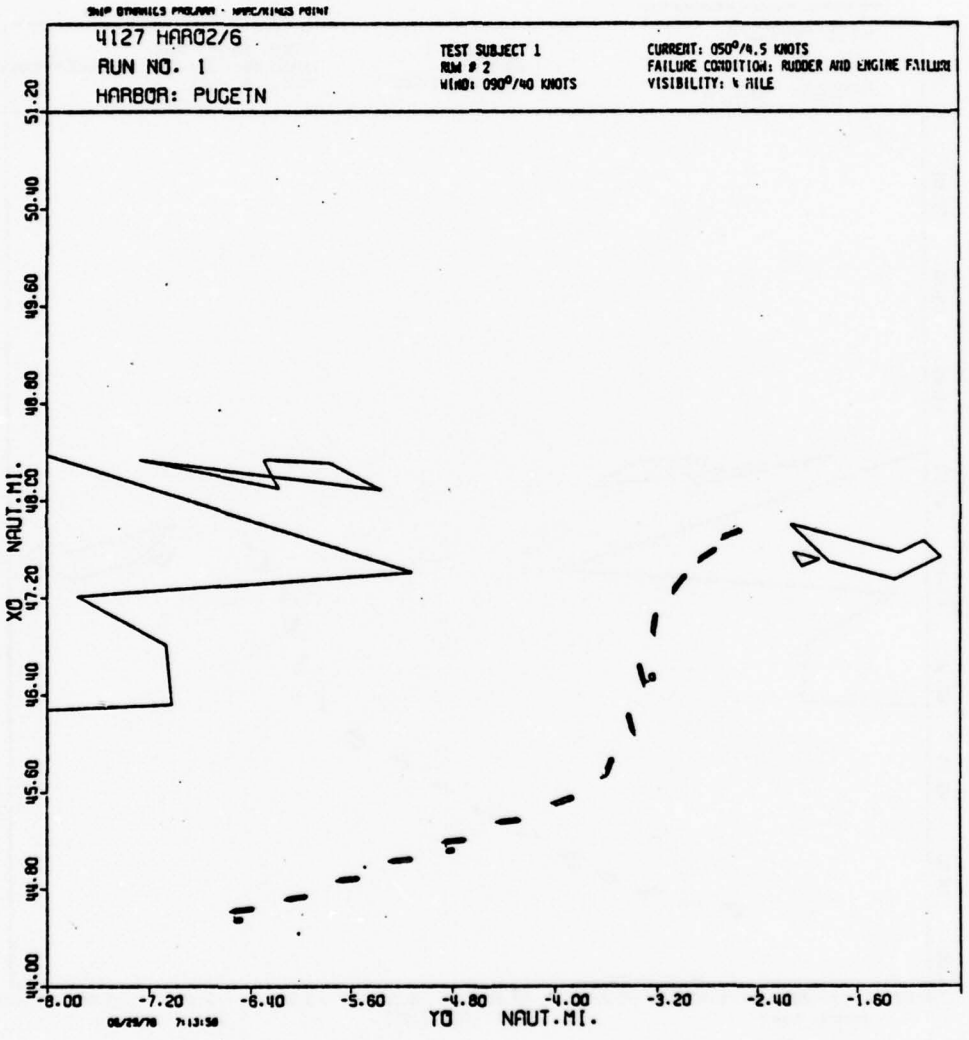
Figure D-2. 80K Tanker in Rosario Strait (Part 4, 50 kt. Wind, 4.8 kt. Current).

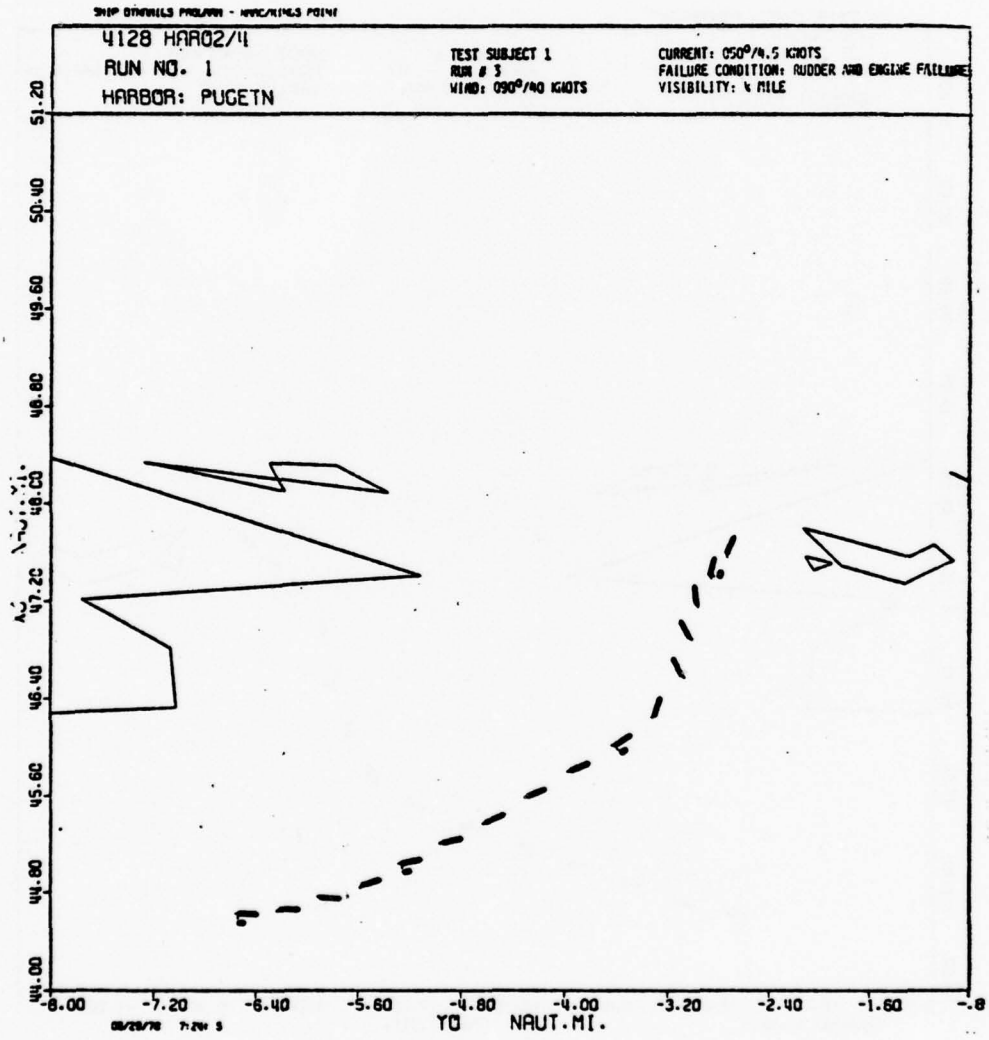
APPENDIX E

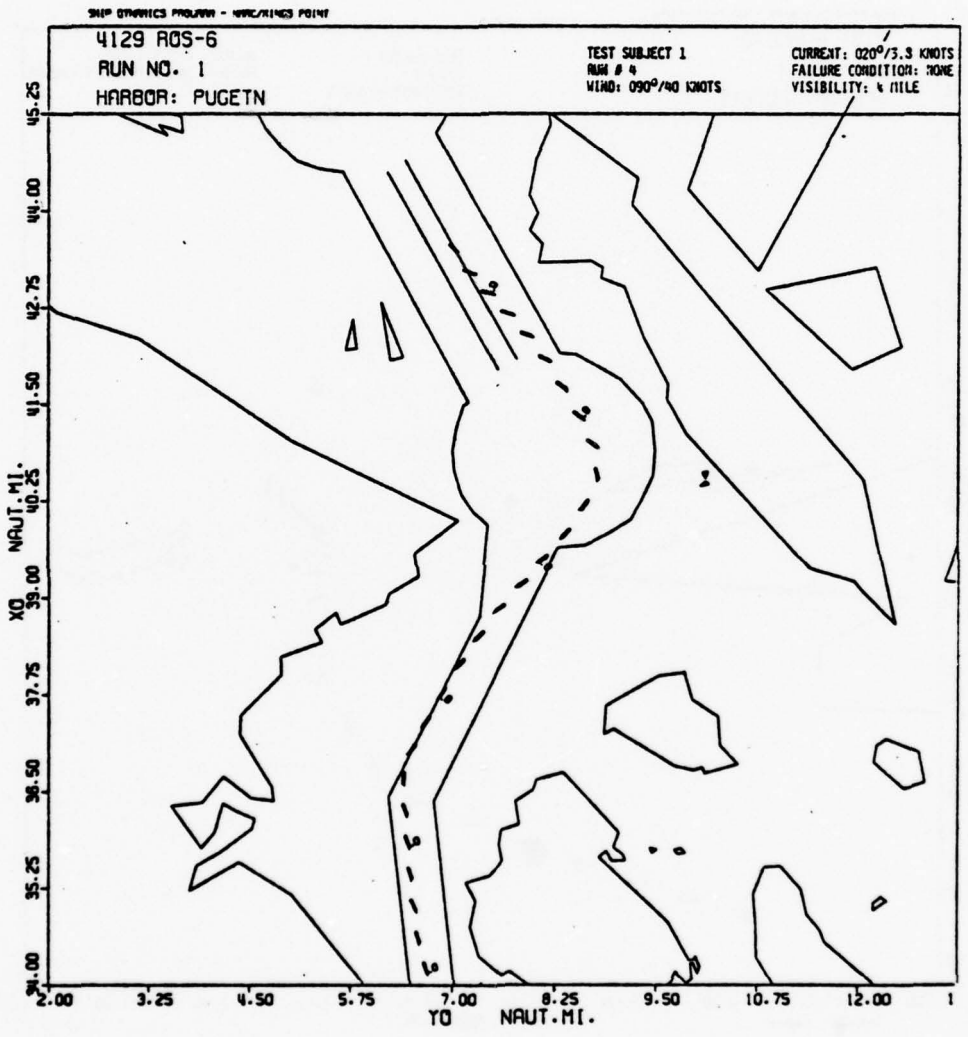
MAN-IN-THE-LOOP SHIP GROUND TRACKS

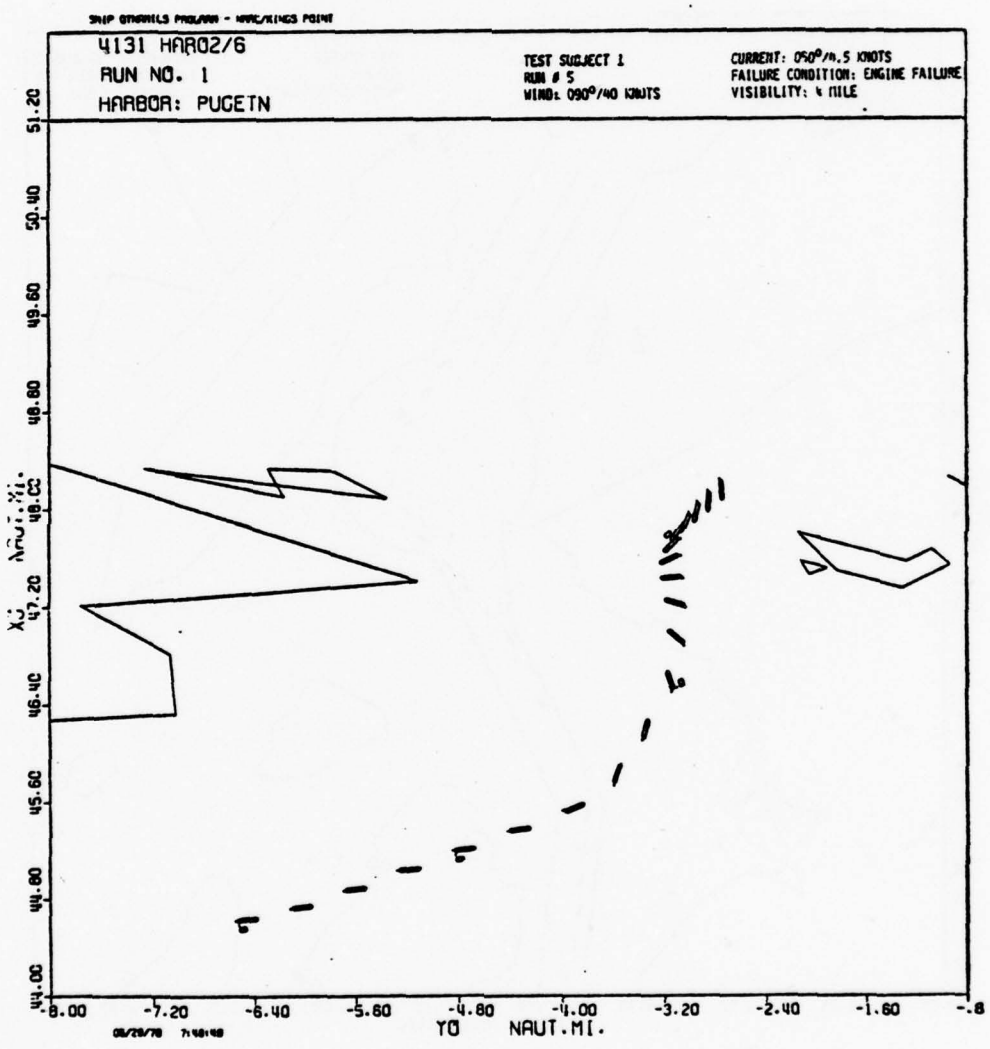
This appendix contains the ground track of each of the piloted simulator runs. In all cases, the ship is the 165,000 DWT tanker and the plot frequency is once every 2 minutes. The conditions for each run are contained in the label in the upper right hand corner of the plot.

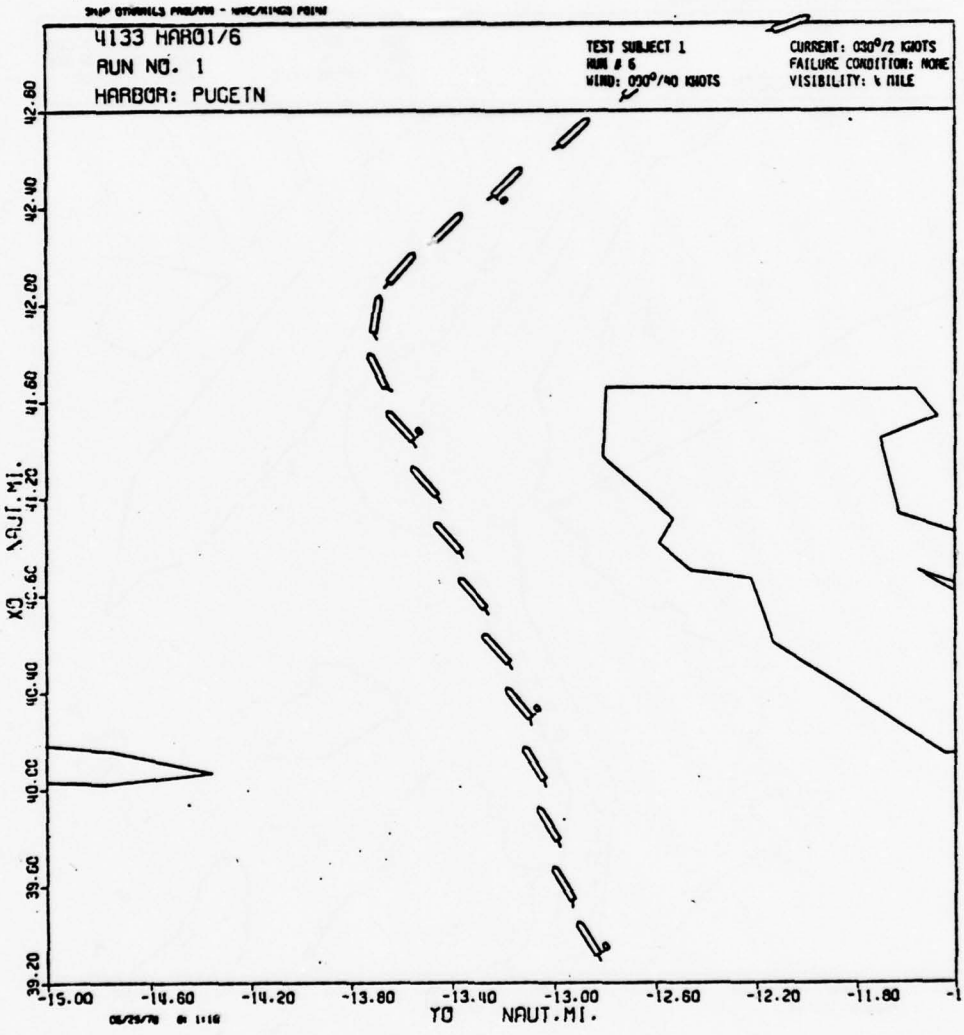

4125 HAR01/4
RUN NO. 1
HARBOR: PUGETN
TEST SUBJECT 1
RUN # 1
WIND: 090°/40 KNOTS
CURRENT: 090°/2 KNOTS
FAILURE CONDITION: NONE
VISIBILITY: ½ MILE
XG NAUT.MI.
42.80
42.40
42.00
41.60
41.20
40.80
40.40
40.00
39.60
39.20
-15.00
-14.60
-14.20
-13.80
-13.40
-13.00
-12.60
-12.20
-11.80
YG NAUT.MI.

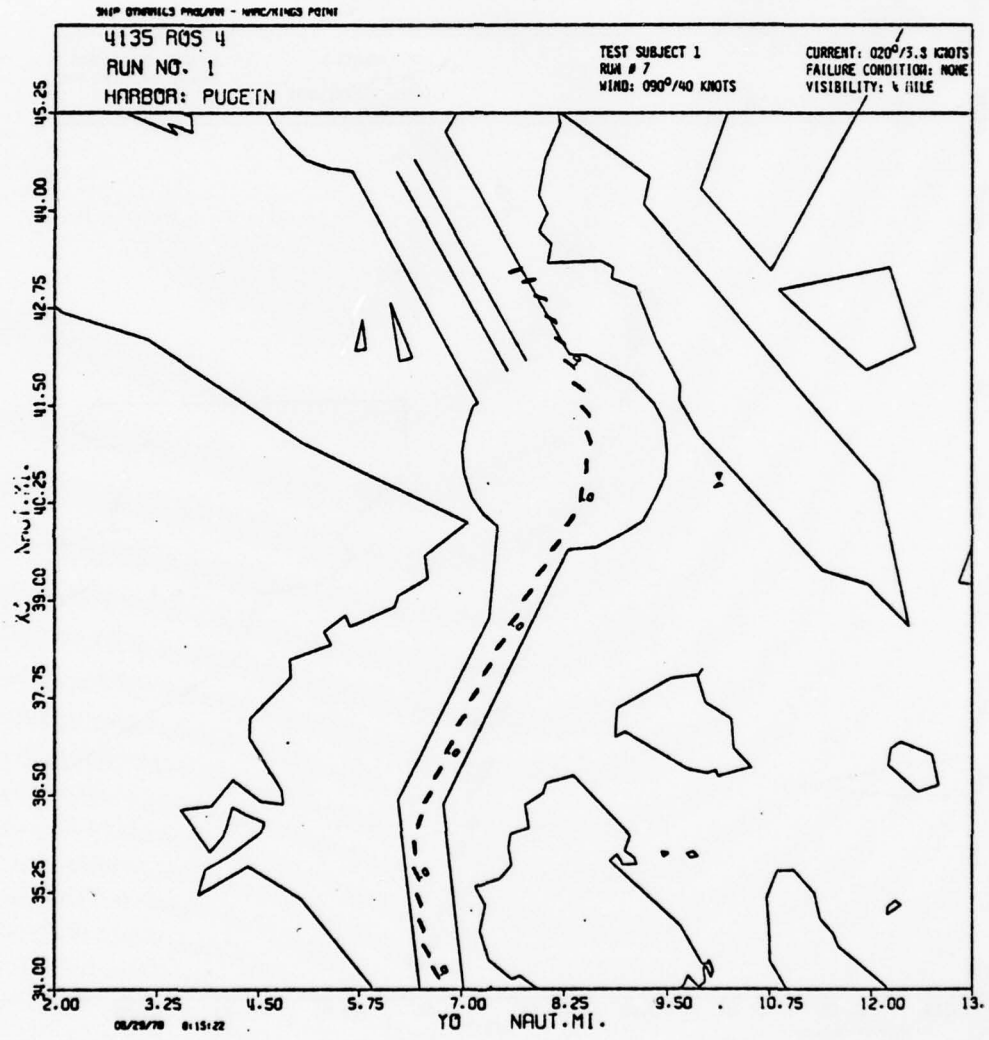

SHIP DYNAMICS PROGRAM - HARBOR/APPROACH POINT
4127 HAR02/6
RUN NO. 1
HARBOR: PUGETN
TEST SUBJECT 1
RUN # 2
WIND: 090°/40 KNOTS
CURRENT: 050°/4.5 KNOTS
FAILURE CONDITION: RUDDER AND ENGINE FAILURE
VISIBILITY: ¼ MILE
XO NAUT.MI.
51.20
50.40
49.60
48.80
48.00
47.20
46.40
45.60
44.80
44.00
-8.00
-7.20
-6.40
-5.60
-4.80
-4.00
-3.20
-2.40
-1.60
YO NAUT.MI.
08/29/78 7:13:58

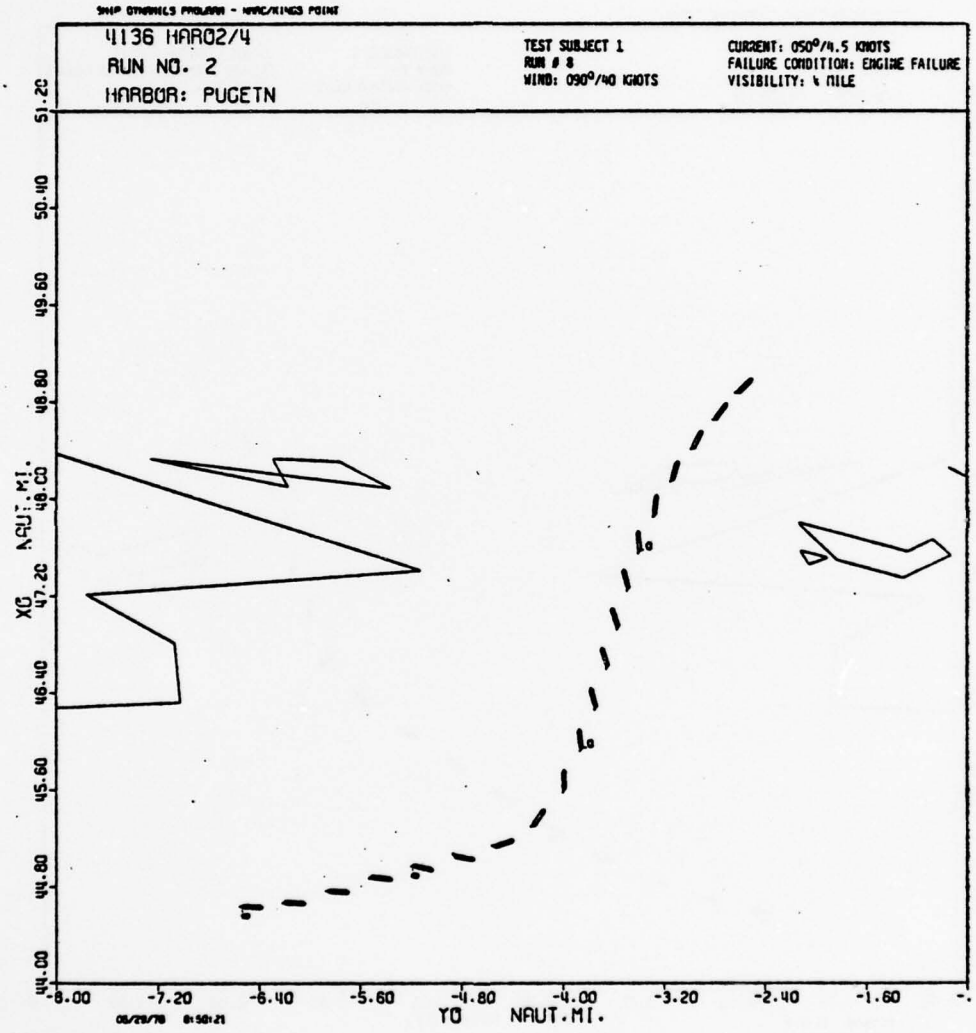

4128 HAR02/4
RUN NO. 1
HARBOR: PUGETN
TEST SUBJECT 1
RUN # 3
WIND: 090°/40 KNOTS
CURRENT: 050°/4.5 KNOTS
VISIBILITY: ¼ MILE
51.20
50.40
49.60
48.80
48.00
47.20
46.40
45.60
44.80
44.00
-8.00
-7.20
-6.40
-5.60
-4.80
-4.00
-3.20
-2.40
-1.60
-.8
YD NAUT.MI.

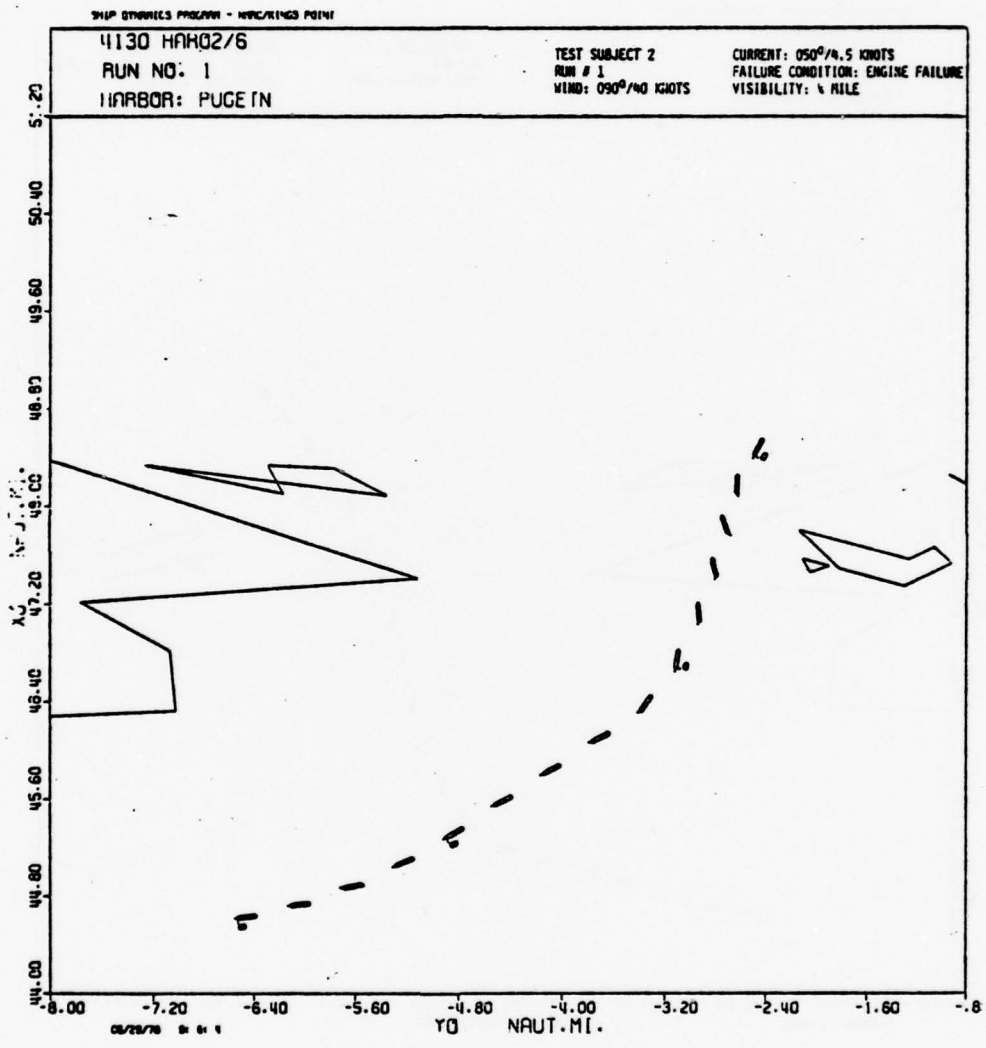

4129 AOS-6
RUN NO. 1
HARBOR: PUGETN
TEST SUBJECT 1
RUN # 4
WIND: 090°/40 KNOTS
CURRENT: 020°/3.3 KNOTS
FAILURE CONDITION: NONE
VISIBILITY: ¼ MILE
45.25
44.00
42.75
41.50
40.25
39.00
37.75
36.50
35.25
34.00
XO NAUT.MI.
2.00
3.25
4.50
5.75
7.00
8.25
9.50
10.75
12.00
YO NAUT.MI.

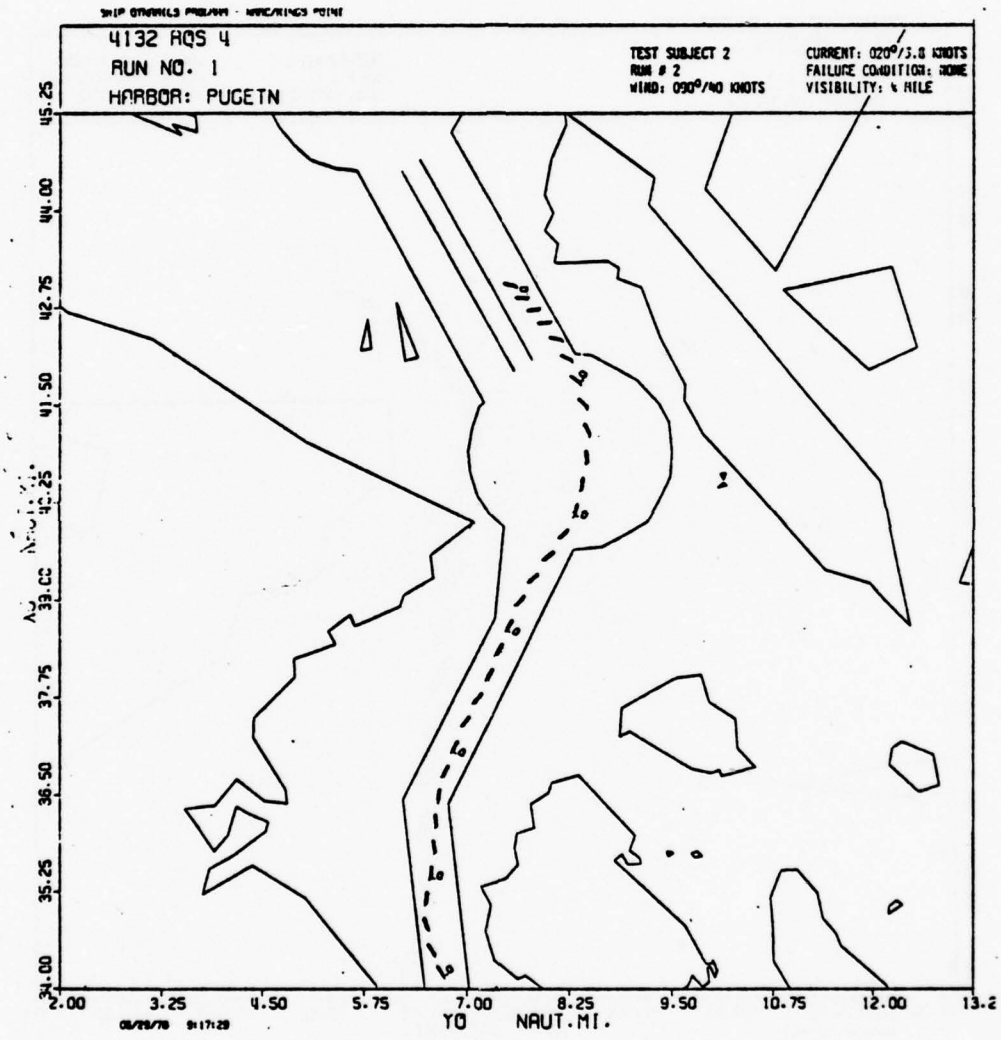

4131 HARO2/6
RUN NO. 1
HARBOR: PUGETN
TEST SUBJECT 1
RUN # 5
WIND: 090°/40 KNOTS
CURRENT: 050°/0.5 KNOTS
FAILURE CONDITION: ENGINE FAILURE
VISIBILITY: ¼ MILE
51.20
50.40
49.60
48.80
48.00
47.20
46.40
45.60
44.80
44.00
-8.00
-7.20
-6.40
-5.60
-4.80
-4.00
-3.20
-2.40
-1.60
-.8
YD NAUT.MI.

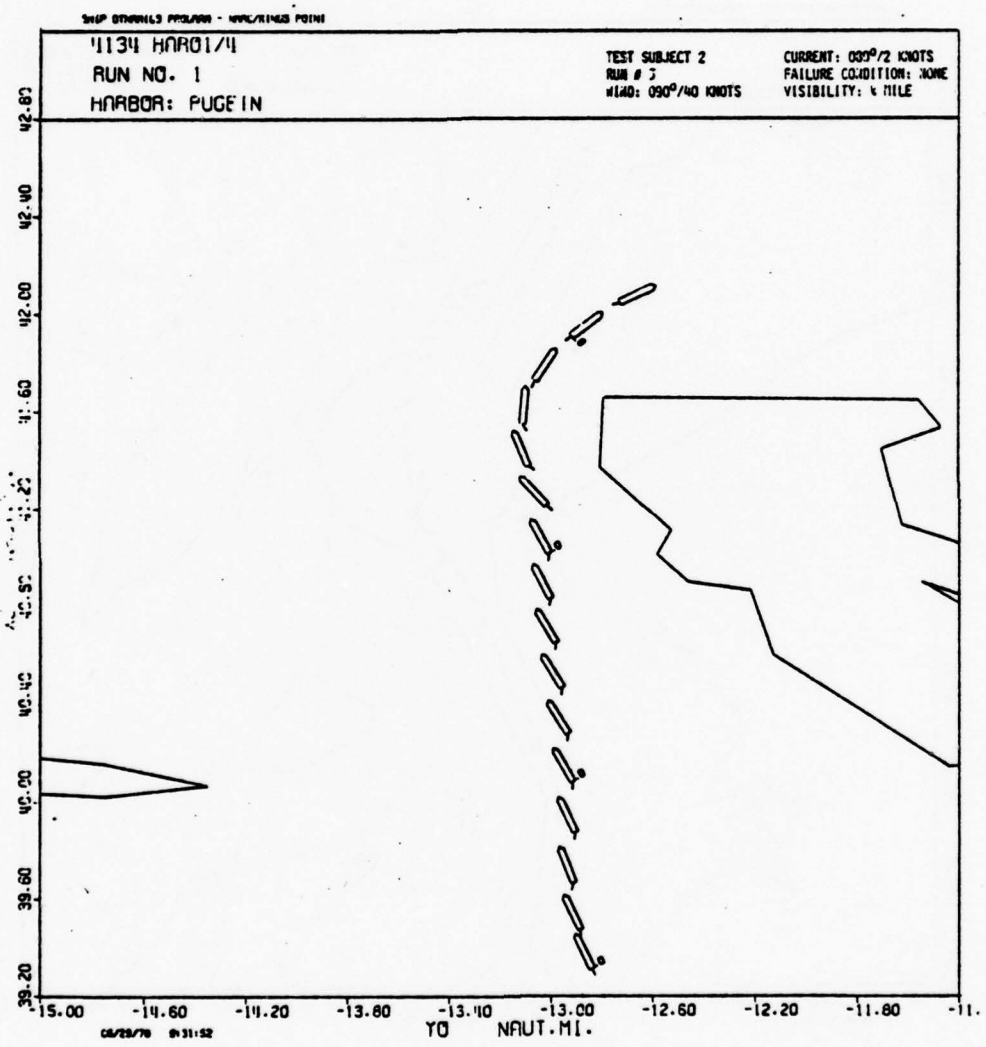

4133 HAR01/6
RUN NO. 1
HARBOR: PUGETN
TEST SUBJECT 1
CURRENT: 030°/2 KNOTS
FAILURE CONDITION: NONE
VISIBILITY: ½ MILE
WIND: 030°/40 KNOTS
42.80
42.40
42.00
41.60
41.20
40.80
40.40
40.00
39.60
39.20
XG NAUT.MI.
-15.00
-14.60
-14.20
-13.80
-13.40
-13.00
-12.60
-12.20
-11.80
YG NAUT.MI.

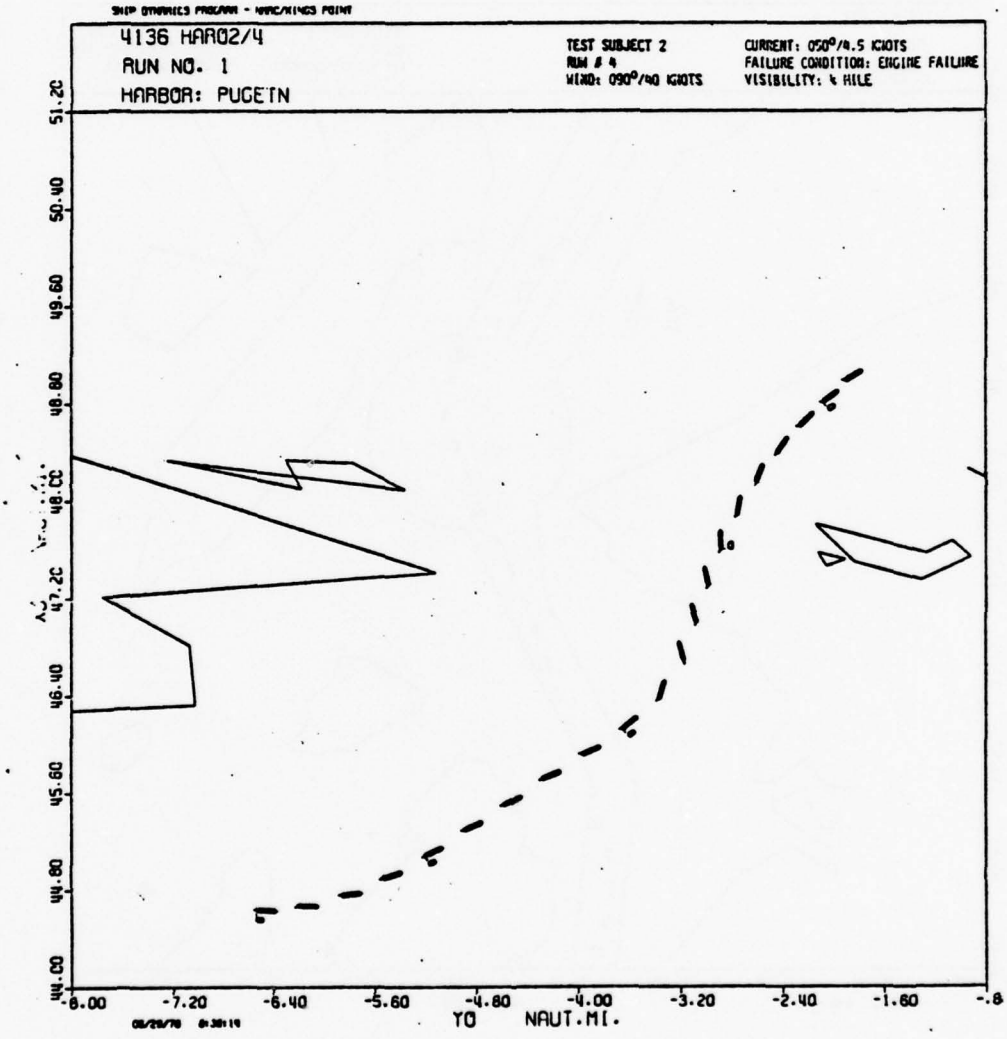

SHIP DYNAMICS PROGRAM - NARC/KINGS POINT
4135 ROS 4
RUN NO. 1
HARBOR: PUGETN
TEST SUBJECT 1
RUN # 7
WIND: 090°/40 KNOTS
CURRENT: 020°/3.3 KNOTS
FAILURE CONDITION: NONE
VISIBILITY: ¼ MILE
45.25
44.00
42.75
41.50
40.25
39.00
37.75
36.50
35.25
34.00
2.00
3.25
4.50
5.75
7.00
8.25
9.50
10.75
12.00
13.
YO NAUT.MI.
08/25/70 0:15:22

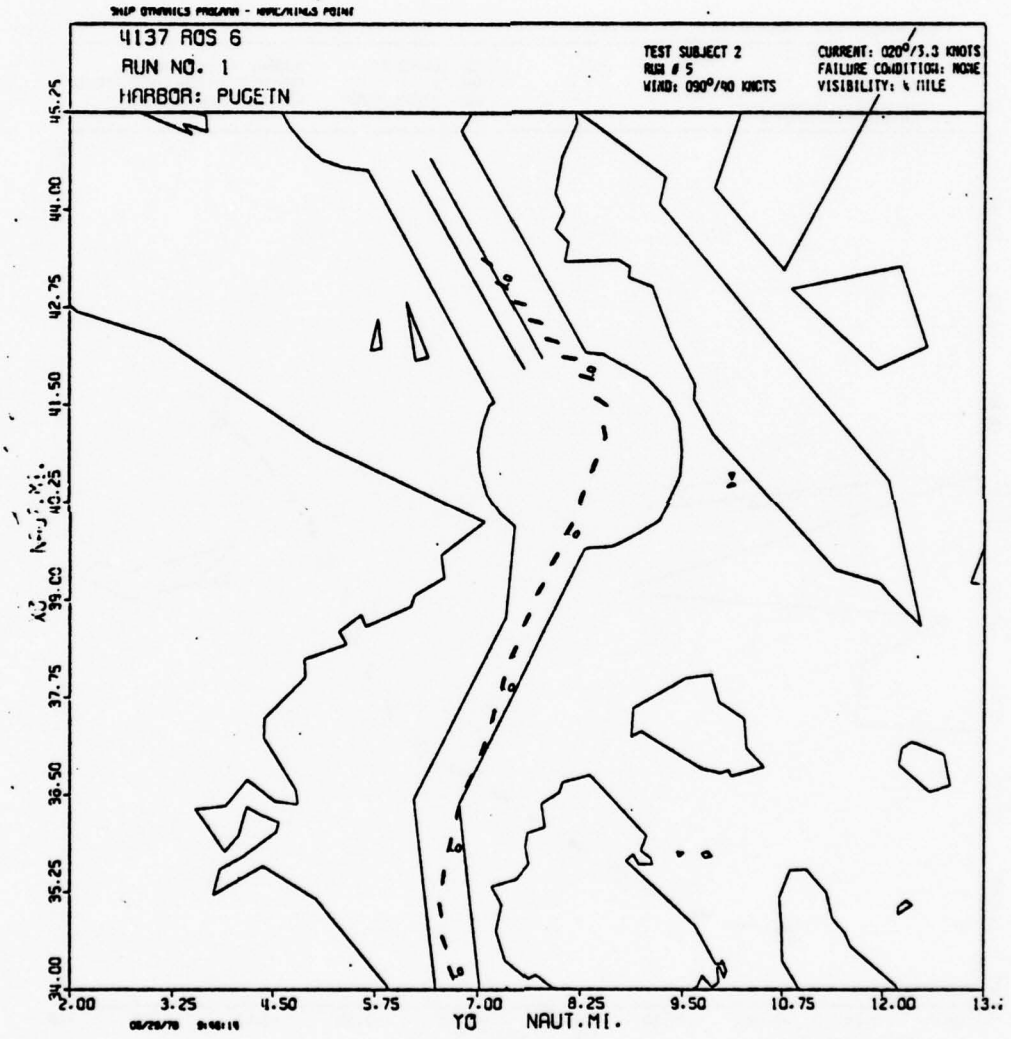

SHIP DYNAMICS PROGRAM - HARC/KINGS POINT
4136 HAR02/4
RUN NO. 2
HARBOR: PUGETN
TEST SUBJECT 1
RUN # 8
WIND: 090°/40 KNOTS
CURRENT: 050°/4.5 KNOTS
FAILURE CONDITION: ENGINE FAILURE
VISIBILITY: ¼ MILE
XO NAUT. MI.
51.20
50.40
49.60
48.80
48.00
47.20
46.40
45.60
44.80
44.00
-8.00
-7.20
-6.40
-5.60
-4.80
-4.00
-3.20
-2.40
-1.60
YO NAUT. MI.
08/29/78 01:50:21

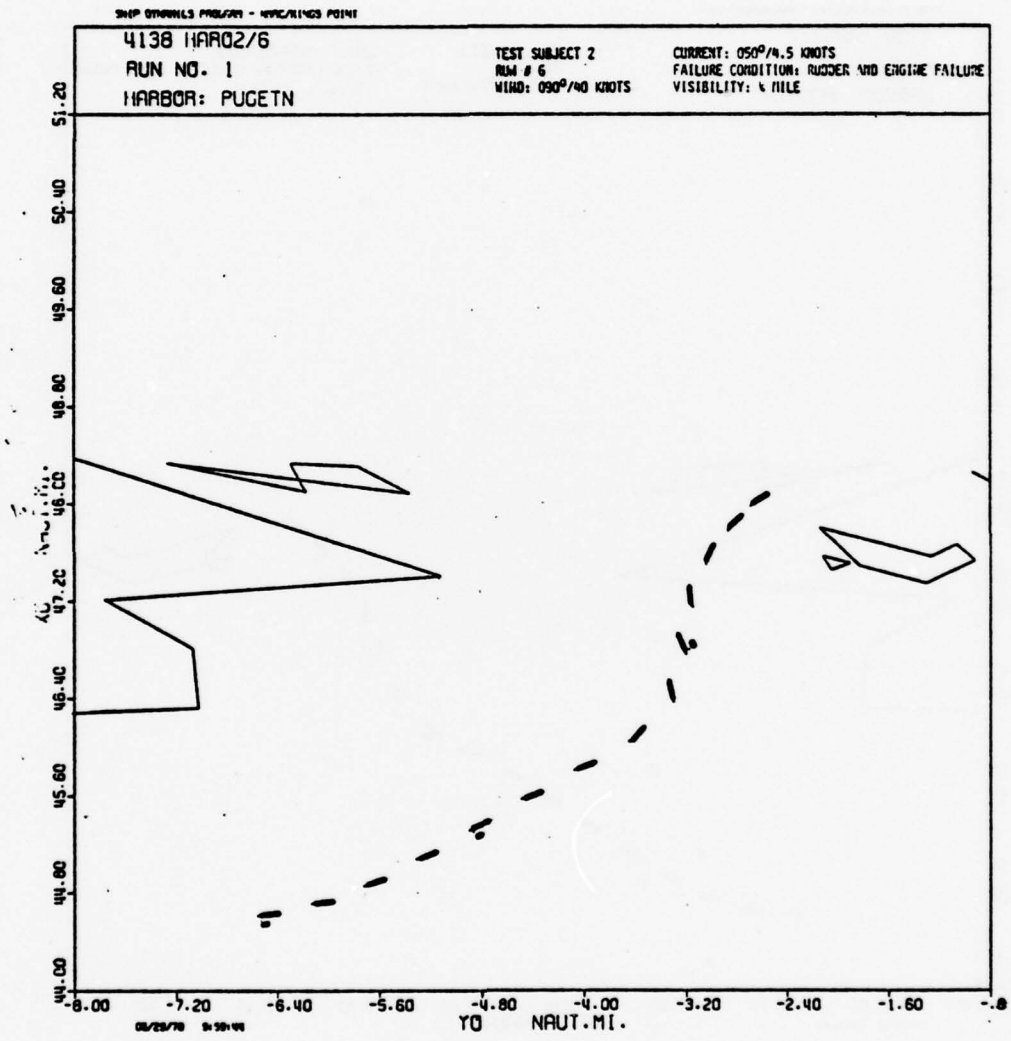

SHIP DYNAMICS PROGRAM - NAVSHIPS POINT
4130 HAR02/6
RUN NO. 1
HARBOR: PUGET N
TEST SUBJECT 2
RUN # 1
WIND: 090°/40 KNOTS
CURRENT: 050°/4.5 KNOTS
FAILURE CONDITION: ENGINE FAILURE
VISIBILITY: ½ MILE
50.40
49.60
48.80
47.20
46.40
45.60
44.80
44.00
-8.00
-7.20
-6.40
-5.60
-4.80
-4.00
-3.20
-2.40
-1.60
YO NAUT.MI.

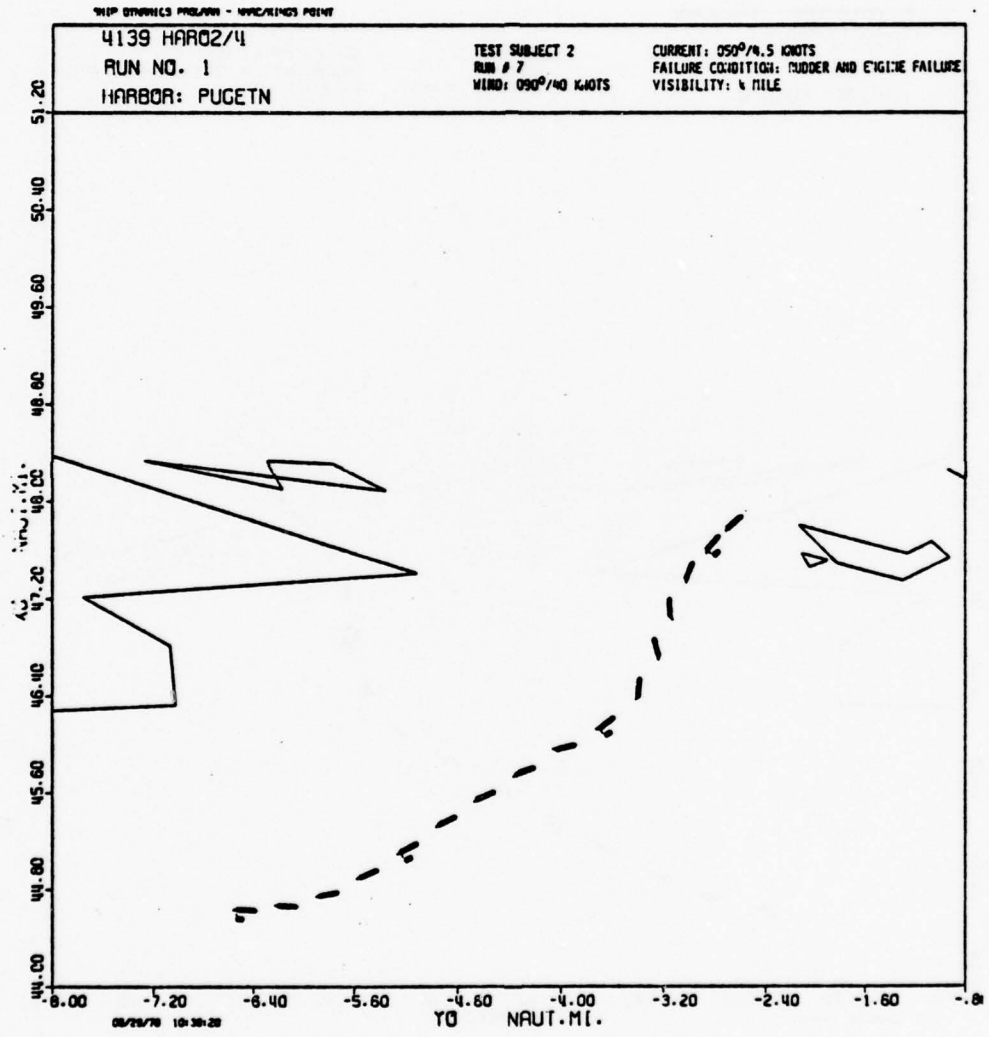

4132 AQS 4
RUN NO. 1
HARBOR: PUGETN
TEST SUBJECT 2
RUN # 2
WIND: 090°/40 KNOTS
CURRENT: 020°/3.8 KNOTS
FAILURE CONDITION: NONE
VISIBILITY: ¼ MILE
45.25
44.00
42.75
41.50
40.25
39.00
37.75
36.50
35.25
34.00
2.00
3.25
4.50
5.75
7.00
8.25
9.50
10.75
12.00
13.2
YD NAUT.MI.

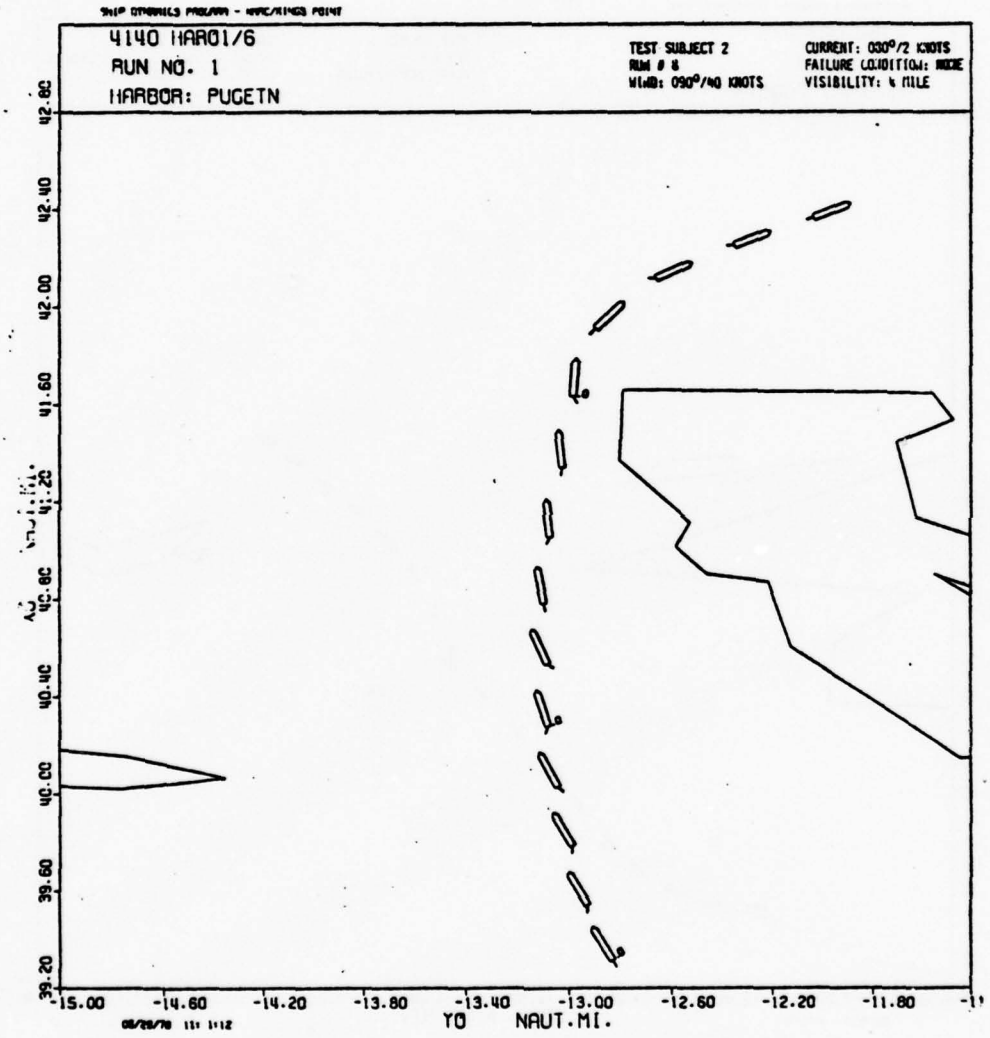

SHIP DYNAMICS PROGRAM - HARC/KINGS POINT
4134 HARB1/4
RUN NO. 1
HARBOR: PUGET IN
TEST SUBJECT 2
RUN # 3
WIND: 090°/40 KNOTS
CURRENT: 030°/2 KNOTS
FAILURE CONDITION: NONE
VISIBILITY: ¼ MILE
42.80
42.40
42.00
41.60
41.20
40.80
40.00
39.60
39.20
-15.00
-14.60
-14.20
-13.80
-13.40
-13.00
-12.60
-12.20
-11.80
-11.
08/28/70 09:31:52
YD NAUT.MI.

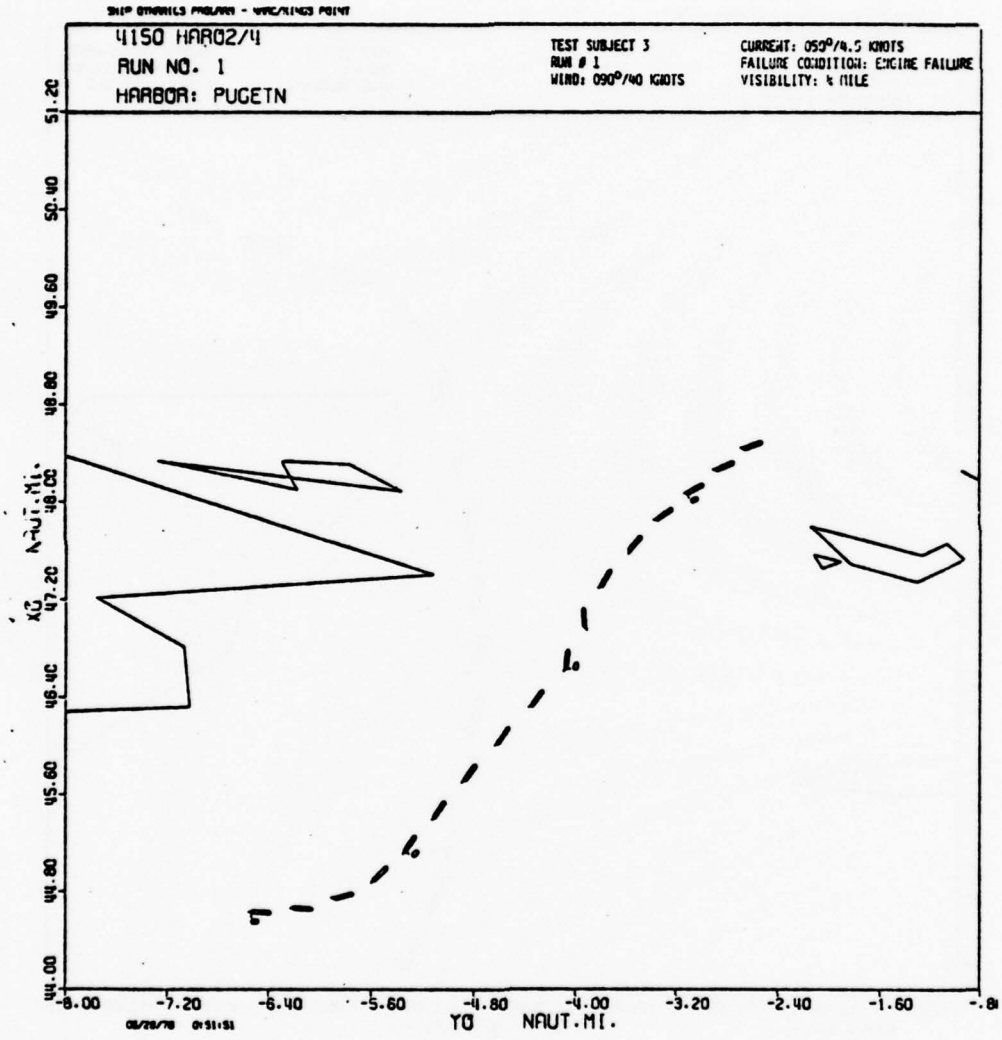

SHIP DYNAMICS PROGRAM - HARC/KINGS POINT
4136 HAR02/4
RUN NO. 1
HARBOR: PUGETN
TEST SUBJECT 2
RUN # 4
WIND: 090°/20 KNOTS
CURRENT: 050°/0.5 KNOTS
FAILURE CONDITION: ENGINE FAILURE
VISIBILITY: ½ MILE
51.20
50.40
49.60
48.80
48.00
47.20
46.40
45.60
44.80
44.00
-8.00
-7.20
-6.40
-5.60
-4.80
-4.00
-3.20
-2.40
-1.60
-.8
YD NAUT.MI.

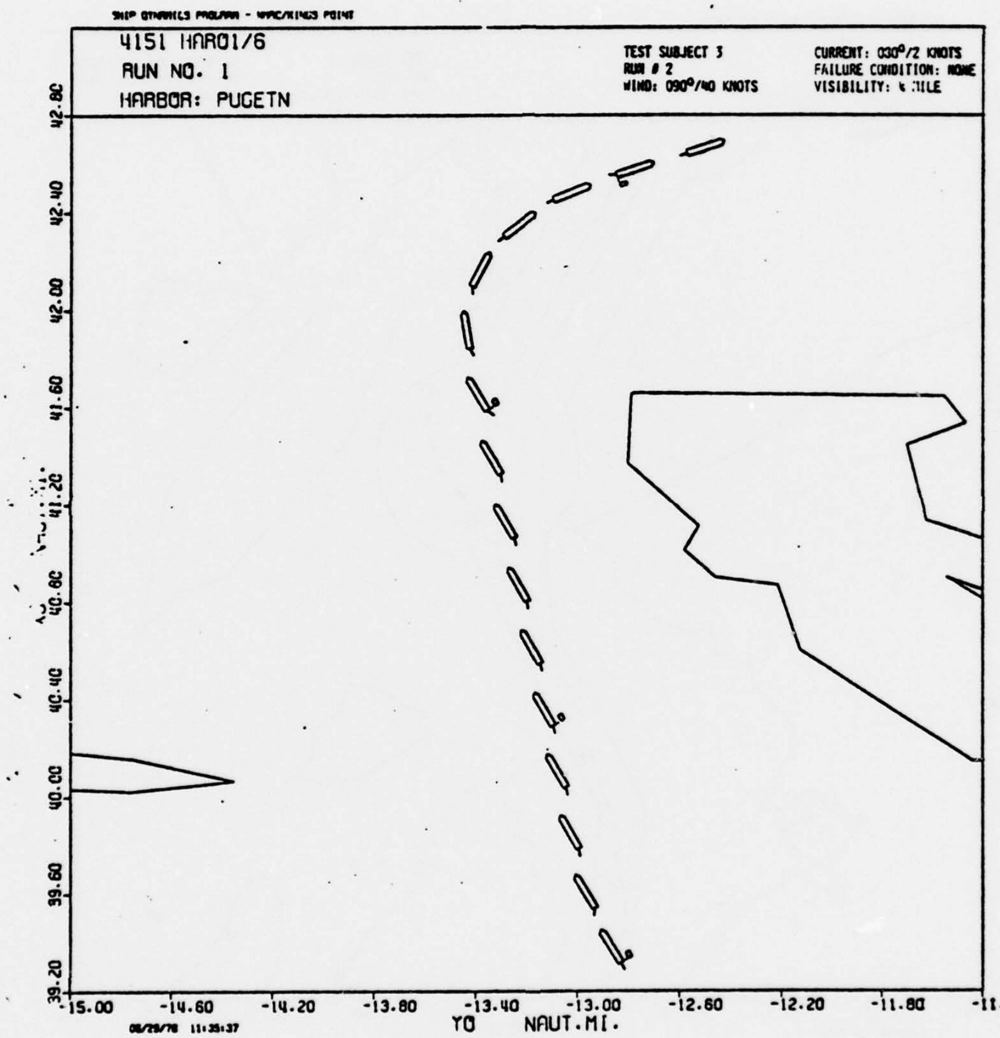

SHIP DYNAMICS PROGRAM - NAVSEC/KINGS POINT
4137 ROS 6
RUN NO. 1
HARBOR: PUGETN
TEST SUBJECT 2
RUN # 5
WIND: 090°/90 KNOTS
CURRENT: 020°/3.3 KNOTS
FAILURE CONDITION: NONE
VISIBILITY: 4 MILE
45.25
44.00
42.75
41.50
40.25
39.00
37.75
36.50
35.25
34.00
2.00
3.25
4.50
5.75
7.00
8.25
9.50
10.75
12.00
YO NAUT.MI.

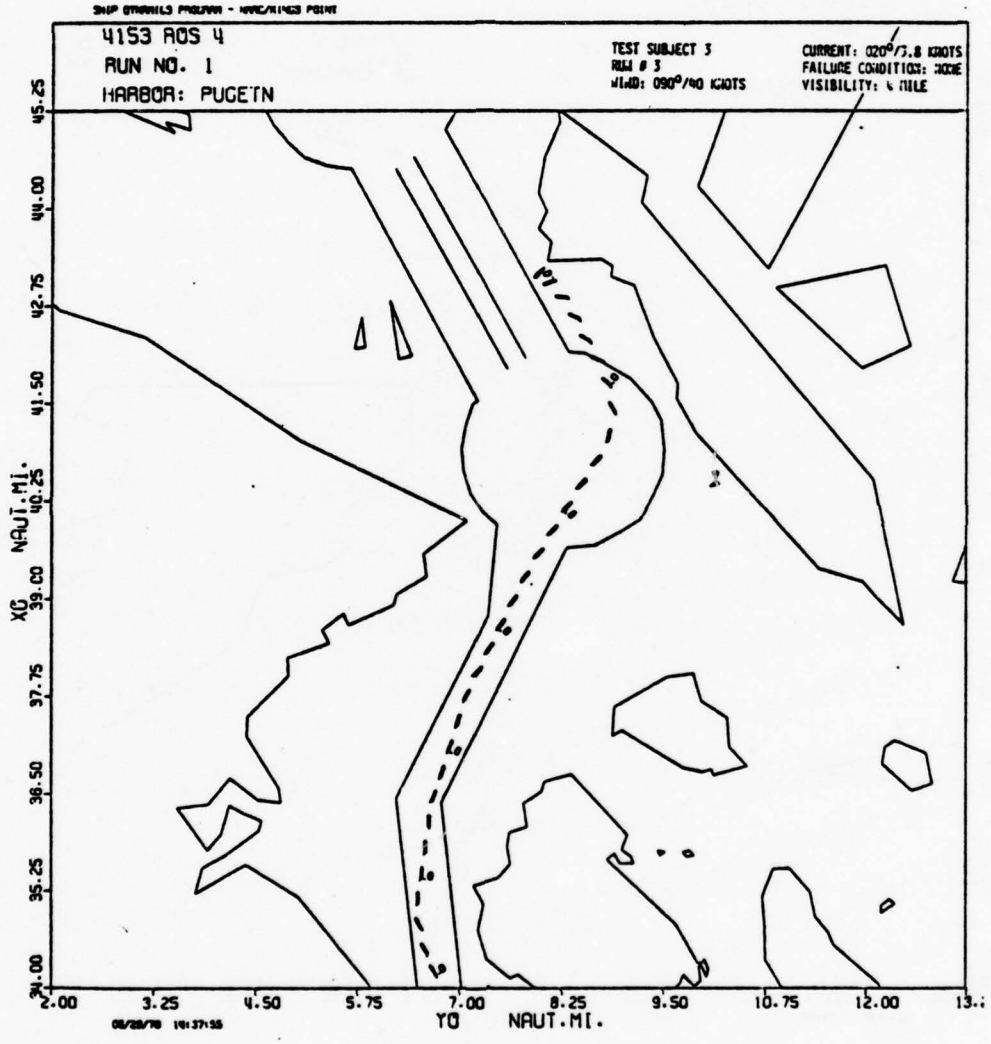

SHIP DYNAMICS PROGRAM - WAVE/WINDS POINT
4138 HARO2/6
RUN NO. 1
HARBOR: PUGETN
TEST SUBJECT 2
RUN # 6
WIND: 090°/40 KNOTS
CURRENT: 050°/4.5 KNOTS
FAILURE CONDITION: RUDDER AND ENGINE FAILURE
VISIBILITY: ½ MILE
51.20
50.40
49.60
48.80
48.00
47.20
46.40
45.60
44.80
44.00
-8.00
-7.20
-6.40
-5.60
-4.80
-4.00
-3.20
-2.40
-1.60
-.8
YO
NAUT.MI.

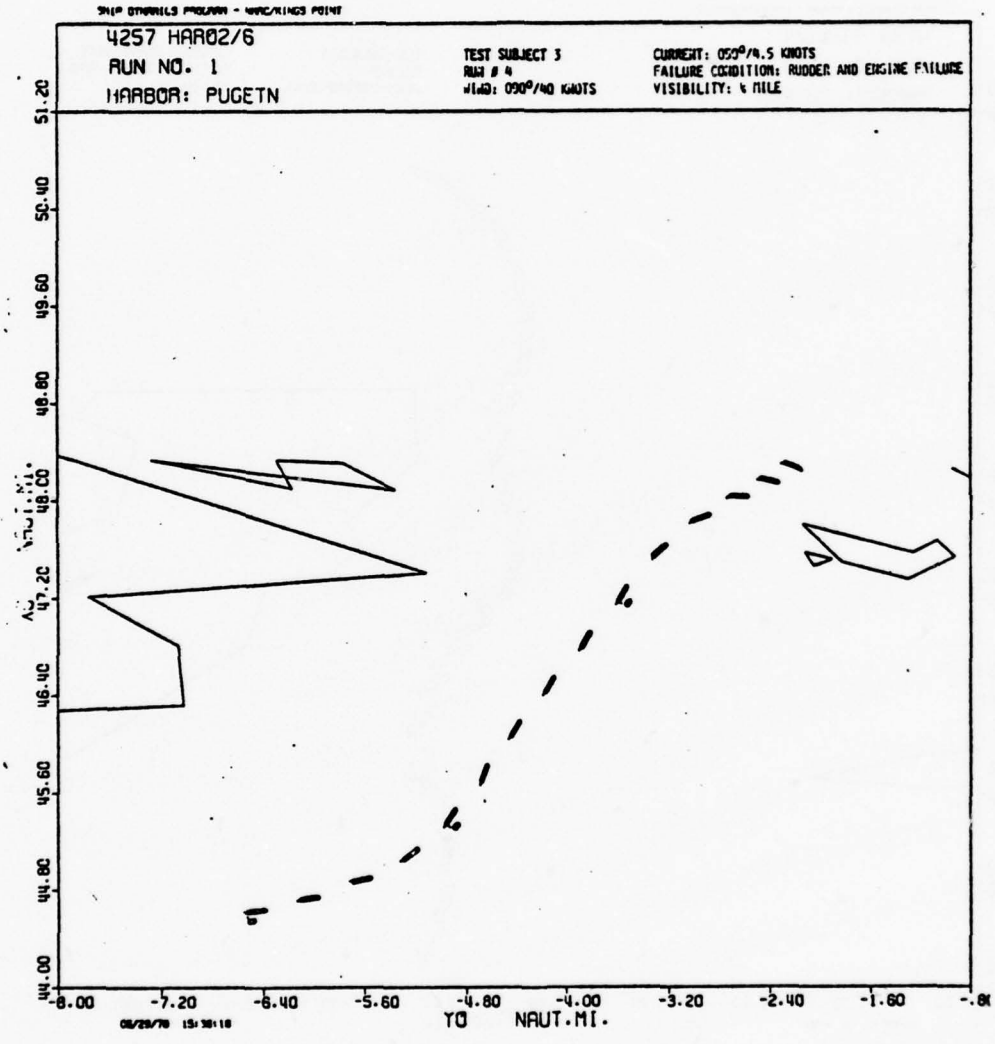

SHIP DYNAMICS PROGRAM - WAVE/WINDS POINT
4139 HARB2/4
RUN NO. 1
HARBOR: PUGETN
TEST SUBJECT 2
RUN # 7
WIND: 090°/40 KNOTS
CURRENT: 050°/0.5 KNOTS
FAILURE CONDITION: RUDDER AND ENGINE FAILURE
VISIBILITY: ¼ MILE
51.20
50.40
49.60
48.80
48.00
47.20
46.40
45.60
44.80
44.00
-8.00
-7.20
-6.40
-5.60
-4.60
-4.00
-3.20
-2.40
-1.60
-.8
YD NAUT.MI.
08/29/78 10:30:28

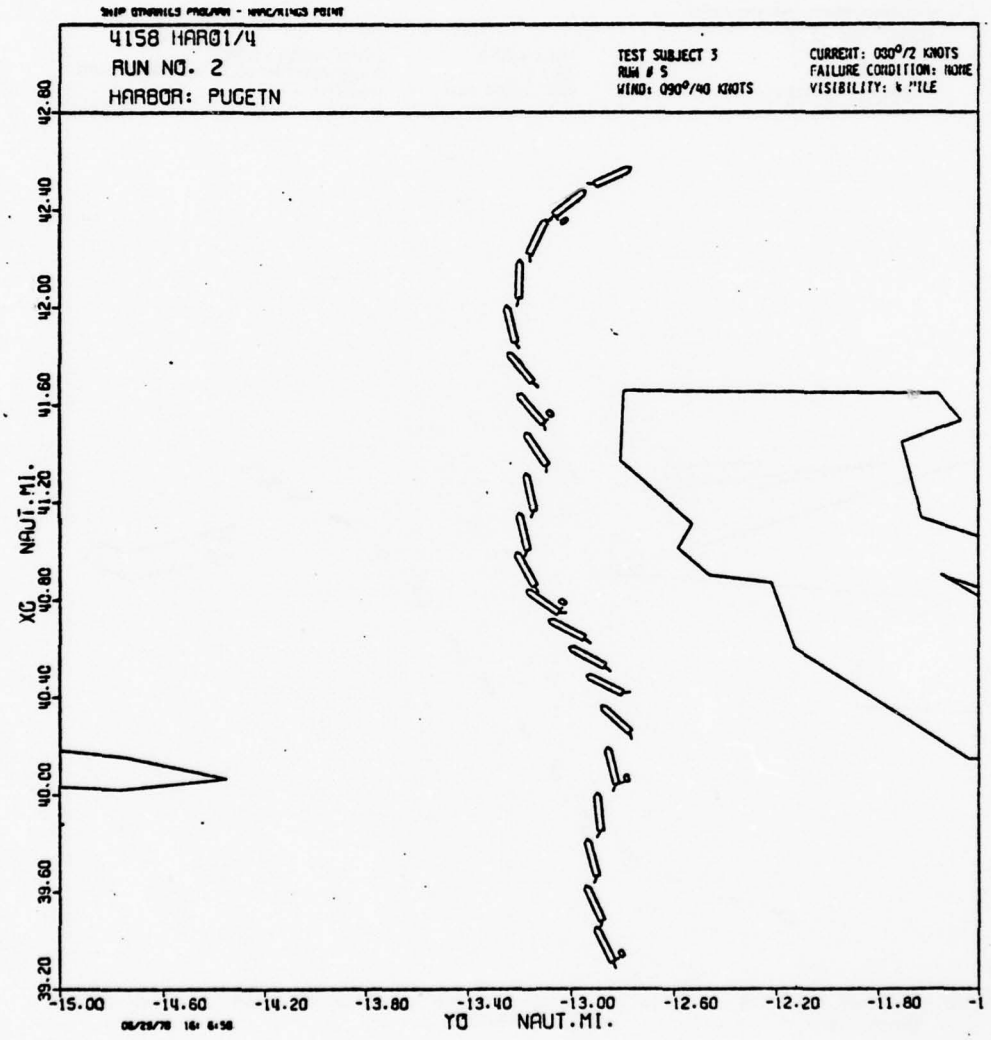

4140 HAR01/6
RUN NO. 1
HARBOR: PUGETN
TEST SUBJECT 2
RUN # 6
WIND: 090°/40 KNOTS
CURRENT: 030°/2 KNOTS
FAILURE CONDITION: NONE
VISIBILITY: 6 MILE
42.80
42.40
42.00
41.60
41.20
40.80
40.40
40.00
39.60
39.20
-15.00
-14.60
-14.20
-13.80
-13.40
-13.00
-12.60
-12.20
-11.80
YD NAUT.MI.

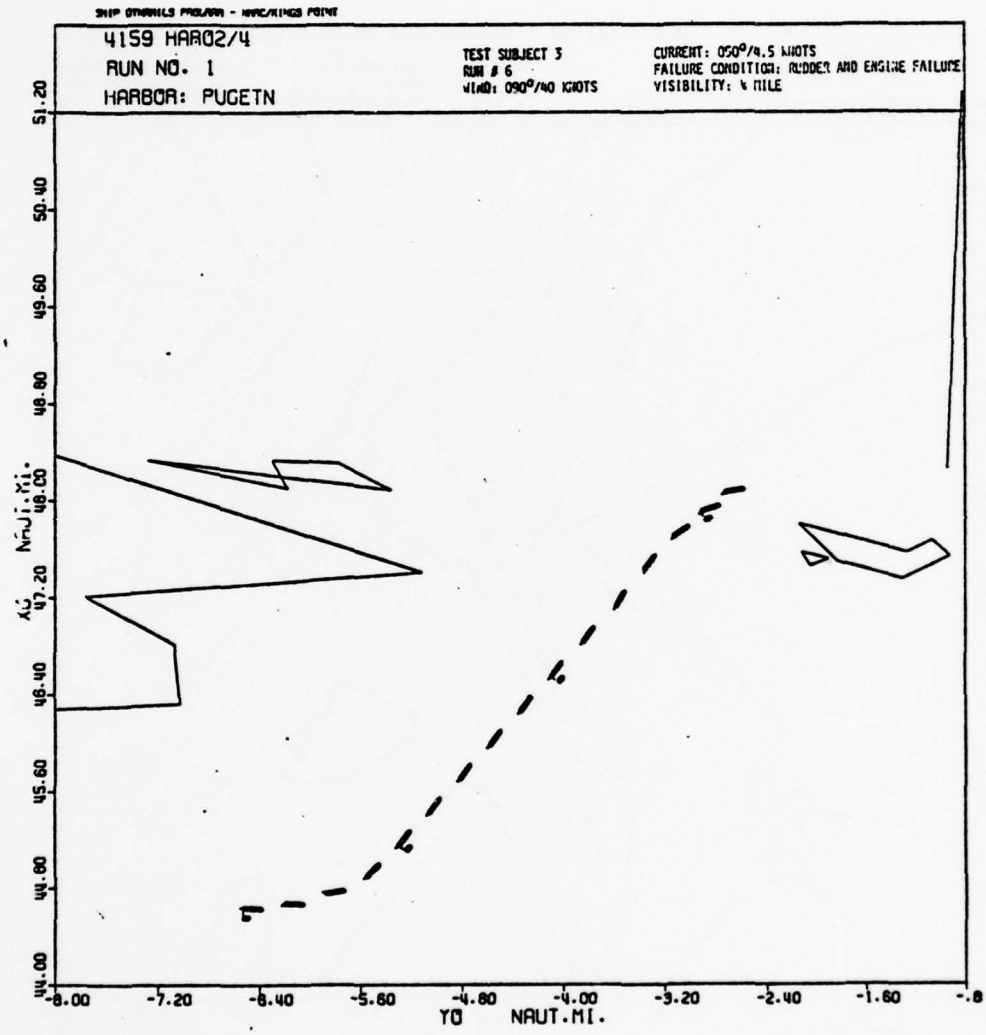

4150 HARB2/4
RUN NO. 1
HARBOR: PUGETN
TEST SUBJECT 3
RUN # 1
WIND: 090°/40 KNOTS
CURRENT: 050°/4.5 KNOTS
FAILURE CONDITION: ENGINE FAILURE
VISIBILITY: ½ MILE
XO NAUT.MI.
YO NAUT.MI.
51.20
50.40
49.60
48.80
48.00
47.20
46.40
45.60
44.80
44.00
-8.00
-7.20
-6.40
-5.60
-4.80
-4.00
-3.20
-2.40
-1.60

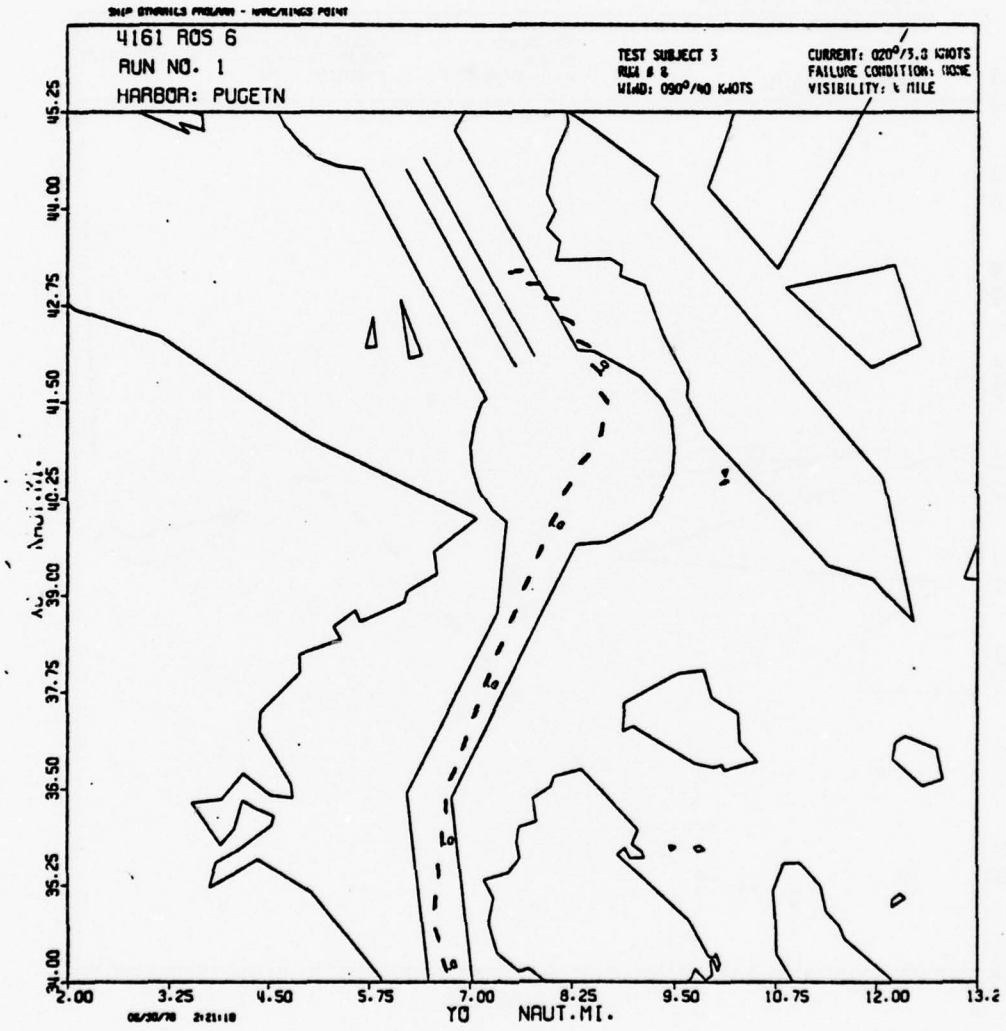

SHIP DYNAMICS PROGRAM - NMRC/KINGS POINT
4151 HAR01/6
RUN NO. 1
HARBOR: PUGETN
TEST SUBJECT 3
RUN # 2
WIND: 090°/40 KNOTS
CURRENT: 030°/2 KNOTS
FAILURE CONDITION: NONE
42.80
42.40
42.00
41.60
41.20
40.80
40.40
40.00
39.60
39.20
-15.00
-14.60
-14.20
-13.80
-13.40
-13.00
-12.60
-12.20
-11.80
YO NAUT.MI.
11:35:37

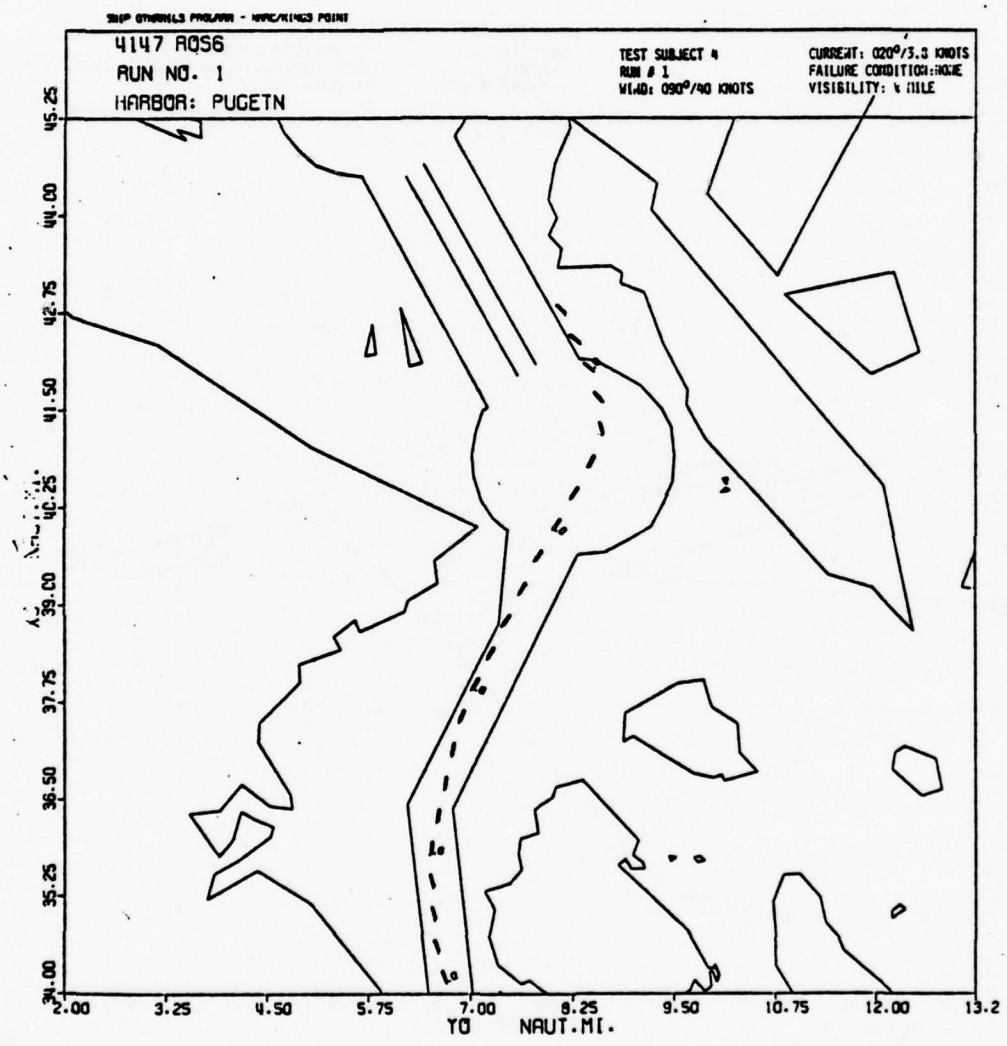

4153 AOS 4
RUN NO. 1
HARBOR: PUGETN
TEST SUBJECT 3
RUN # 3
WIND: 090°/40 KNOTS
CURRENT: 020°/3.8 KNOTS
FAILURE CONDITION: NONE
VISIBILITY: 4 MILE
XO NAUT.MI.
45.25
44.00
42.75
41.50
40.25
39.00
37.75
36.50
35.25
34.00
2.00
3.25
4.50
5.75
7.00
8.25
9.50
10.75
12.00
YO NAUT.MI.

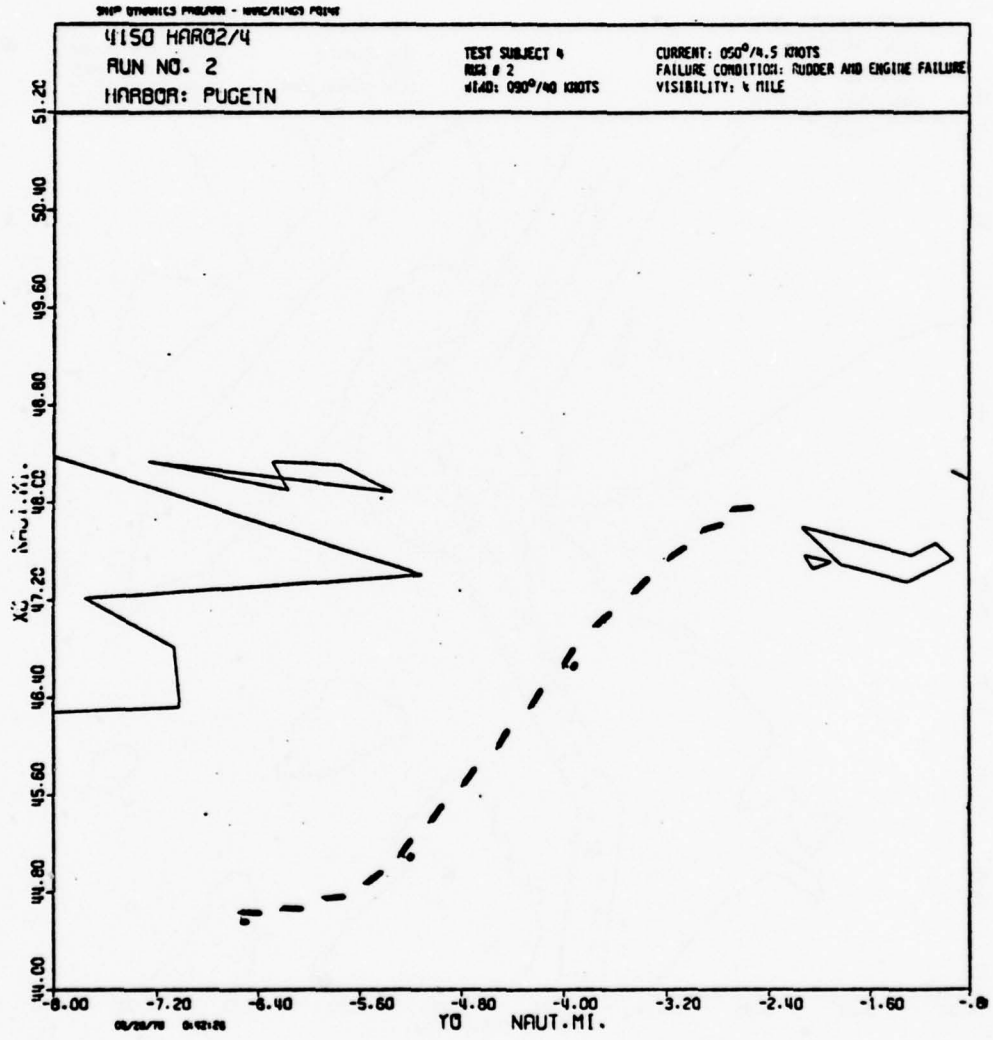

4257 HAR02/6
RUN NO. 1
HARBOR: PUGETN
TEST SUBJECT 3
RUN # 4
WIND: 090°/40 KNOTS
CURRENT: 050°/4.5 KNOTS
FAILURE CONDITION: RUDDER AND ENGINE FAILURE
VISIBILITY: ½ MILE
51.20
50.40
49.60
48.80
48.00
47.20
46.40
45.60
44.80
44.00
-8.00
-7.20
-6.40
-5.60
-4.80
-4.00
-3.20
-2.40
-1.60
YD NAUT.MI.

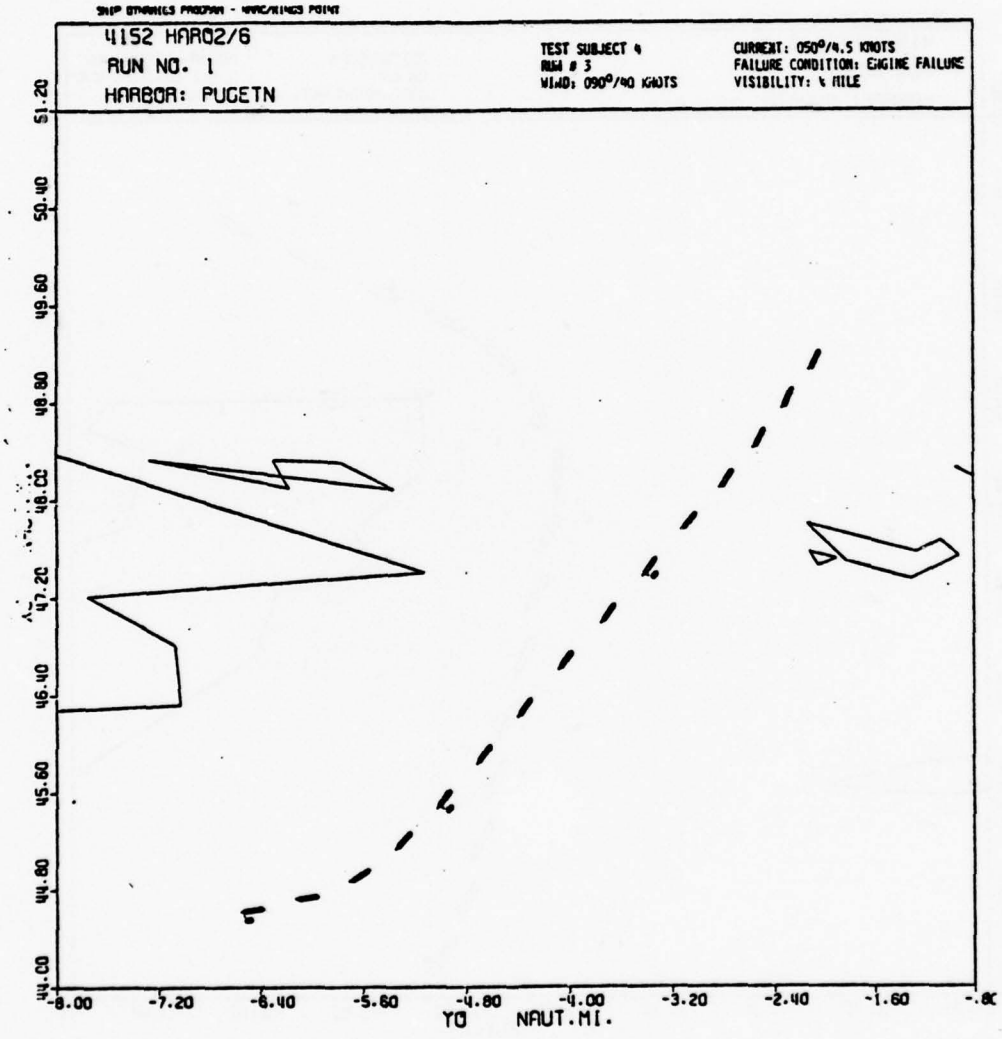

SHIP DYNAMICS PROGRAM - HARC/KINGS POINT
4158 HAR01/4
RUN NO. 2
HARBOR: PUGETN
TEST SUBJECT 3
RUN # 5
WIND: 090°/40 KNOTS
CURRENT: 030°/2 KNOTS
FAILURE CONDITION: NONE
VISIBILITY: 4 MILE
XC NAUT.MI.
42.80
42.40
42.00
41.60
41.20
40.80
40.40
40.00
39.60
39.20
-15.00
-14.60
-14.20
-13.80
-13.40
-13.00
-12.60
-12.20
-11.80
YC NAUT.MI.
05/25/78 16: 6:58

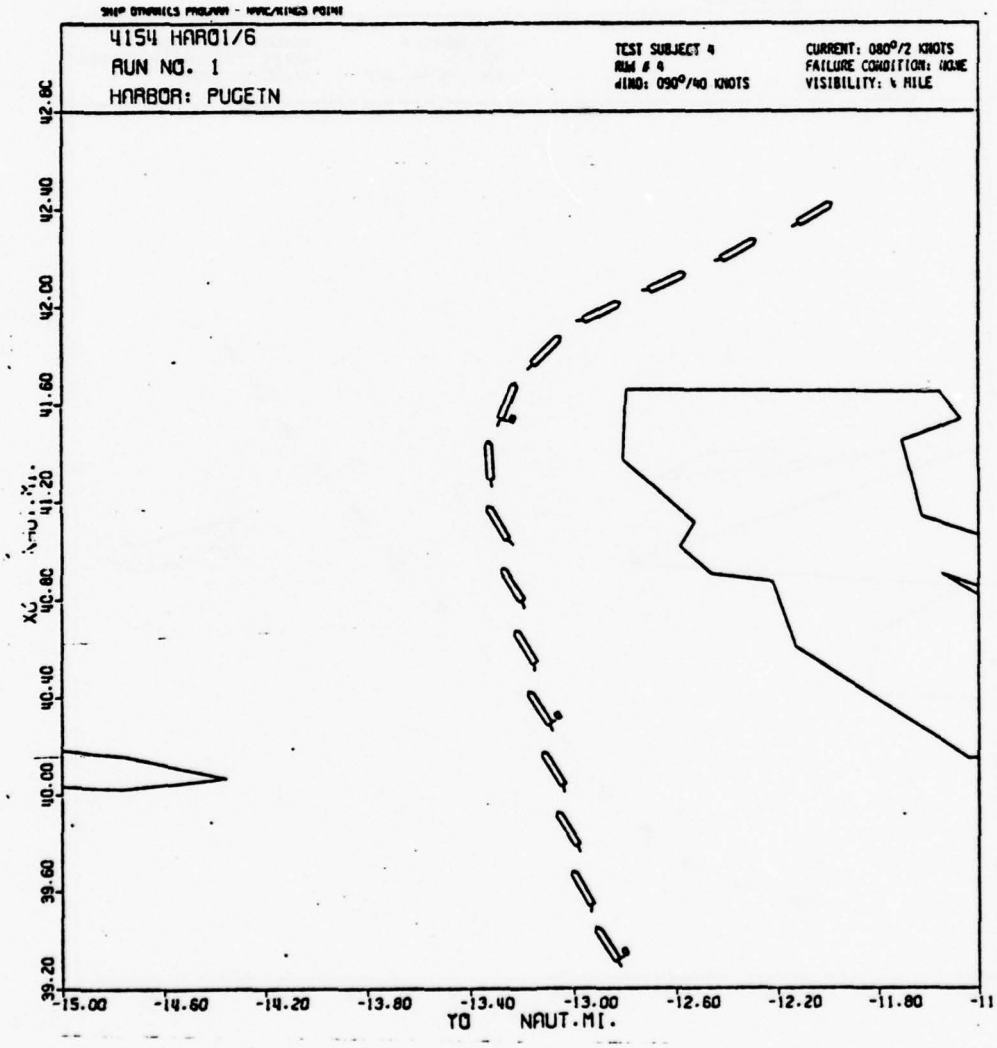

SHIP DYNAMICS PROGRAM - HARBORS POINT
4159 HARB2/4
RUN NO. 1
HARBOR: PUGETN
TEST SUBJECT 3
RUN # 6
WIND: 090°/40 KNOTS
CURRENT: 050°/4.5 KNOTS
FAILURE CONDITION: RUDDER AND ENGINE FAILURE
VISIBILITY: ½ MILE
51.20
50.40
49.60
48.80
48.00
47.20
46.40
45.60
44.80
44.00
XG NAUT.MI.
-8.00
-7.20
-6.40
-5.60
-4.80
-4.00
-3.20
-2.40
-1.60
-.8
YG NAUT.MI.

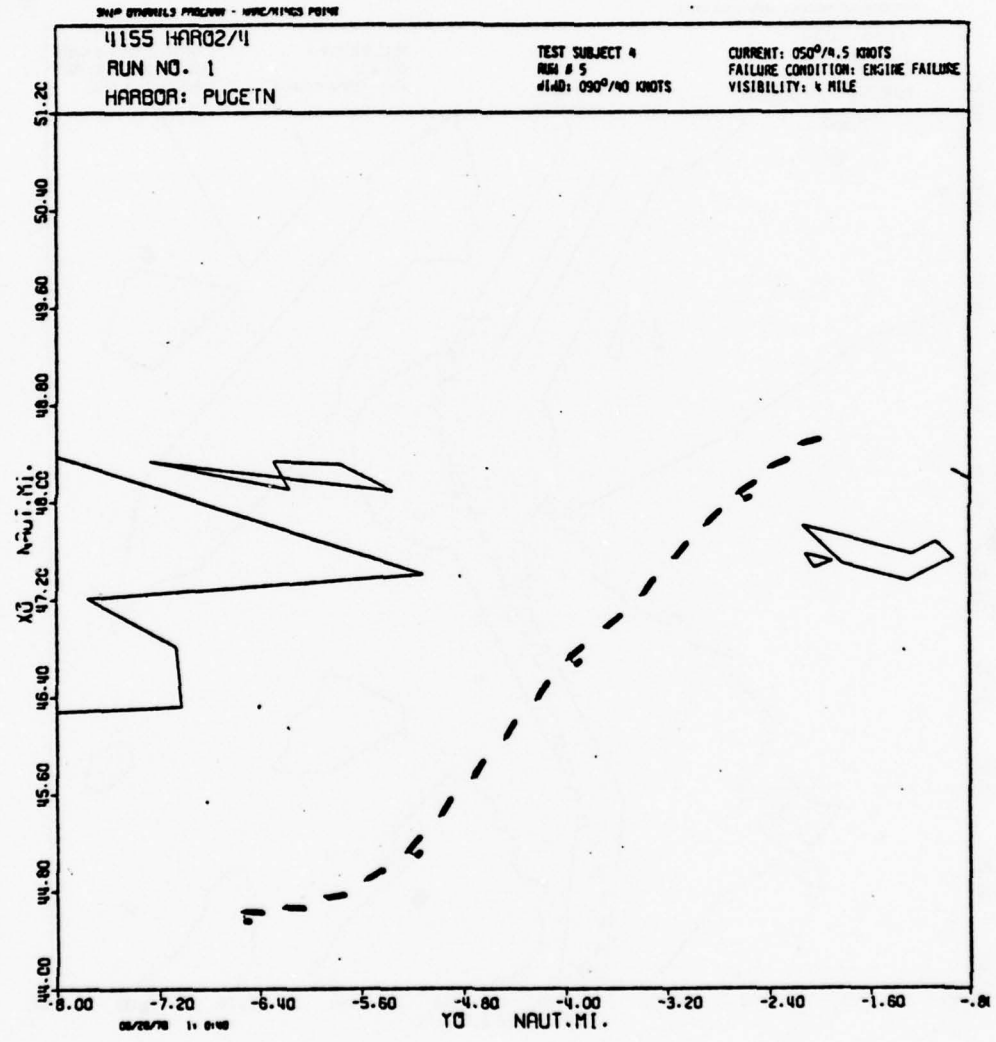

4161 ROS 6
RUN NO. 1
HARBOR: PUGETN
TEST SUBJECT 3
RUN # 8
WIND: 090°/40 KNOTS
CURRENT: 020°/3.0 KNOTS
FAILURE CONDITION: NONE
VISIBILITY: ½ MILE
45.25
44.00
42.75
41.50
40.25
39.00
37.75
36.50
35.25
34.00
2.00
3.25
4.50
5.75
7.00
8.25
9.50
10.75
12.00
YO
NAUT.MI.

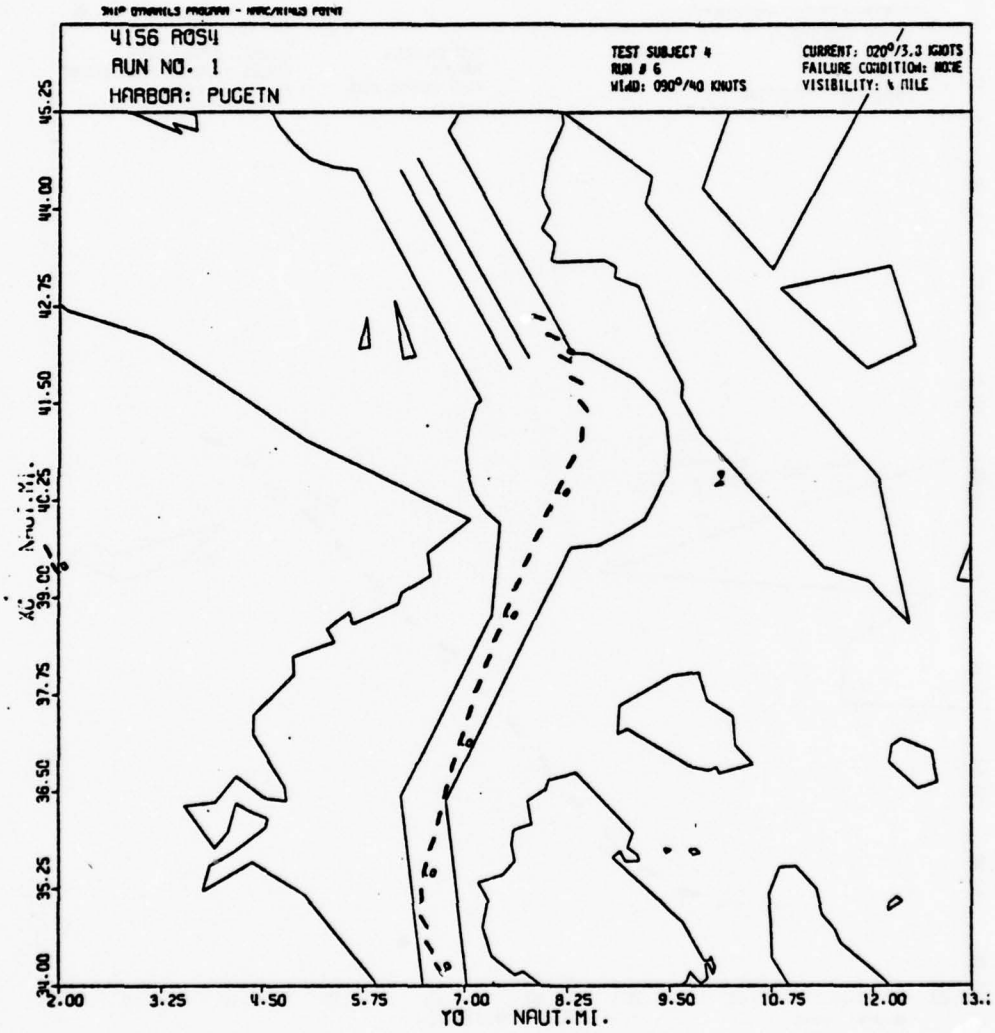

SHIP DYNAMICS PROGRAM - HAVRE/KINGS POINT
4147 AQS6
RUN NO. 1
HARBOR: PUGETN
TEST SUBJECT 4
RUN # 1
WIND: 090°/40 KNOTS
CURRENT: 020°/3.3 KNOTS
FAILURE CONDITION:NONE
VISIBILITY: 4 MILE
45.25
44.00
42.75
41.50
40.25
39.00
37.75
36.50
35.25
34.00
2.00
3.25
4.50
5.75
7.00
8.25
9.50
10.75
12.00
13.2
TO NAUT.MI.

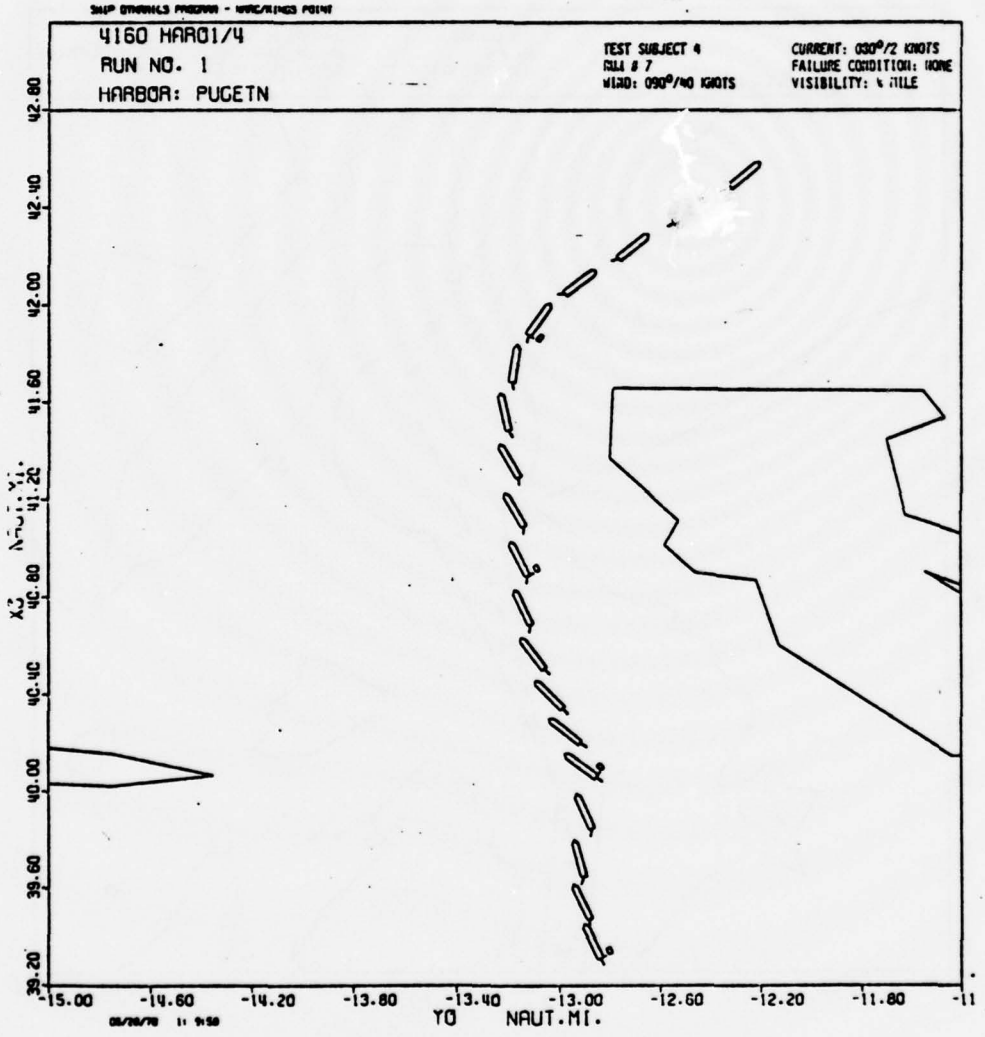

4150 HAR02/4
RUN NO. 2
HARBOR: PUGETN
TEST SUBJECT 4
WIND: 090°/40 KNOTS
CURRENT: 050°/4.5 KNOTS
FAILURE CONDITION: RUDDER AND ENGINE FAILURE
VISIBILITY: ½ MILE
51.20
50.40
49.60
48.80
48.00
47.20
46.40
45.60
44.80
44.00
-8.00
-7.20
-6.40
-5.60
-4.80
-4.00
-3.20
-2.40
-1.60
YO NAUT.MI.

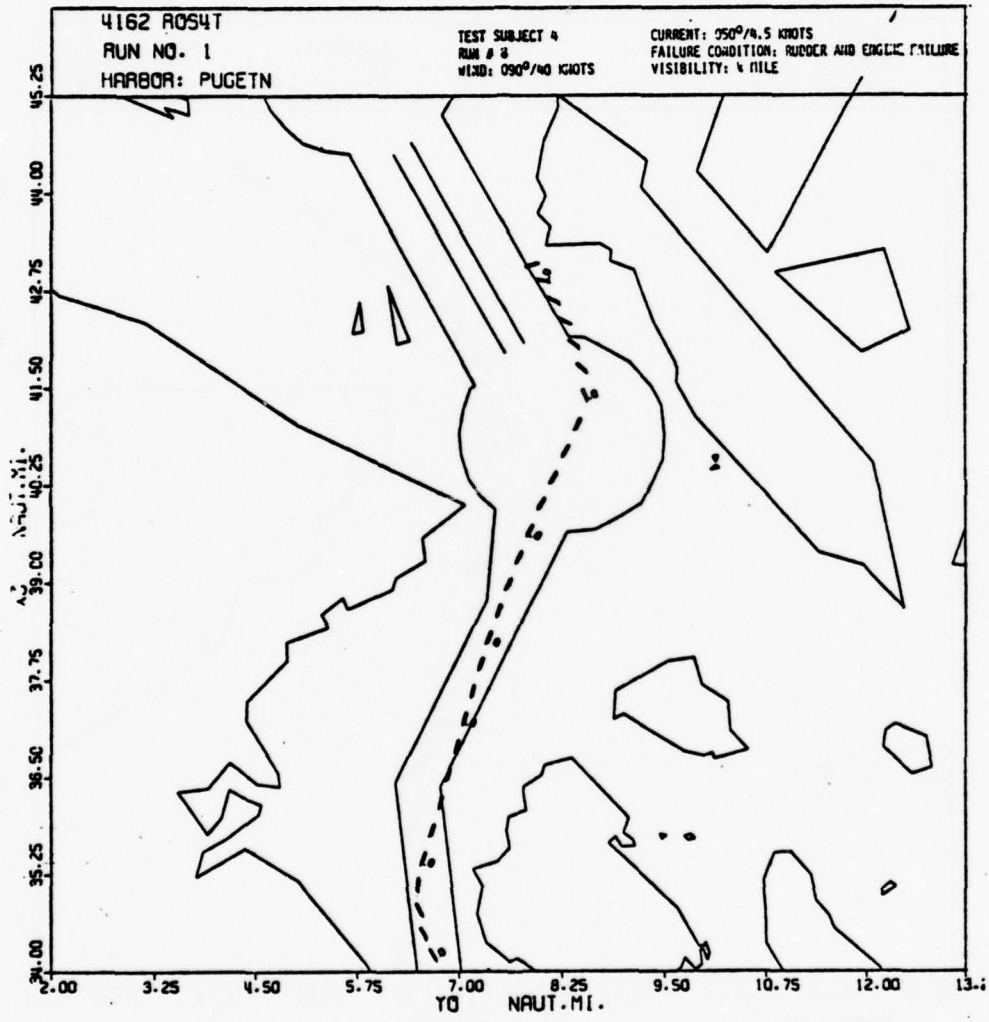

SHIP DYNAMICS PROGRAM - HARC/MINES POINT
4152 HAR02/6
RUN NO. 1
HARBOR: PUGETN
TEST SUBJECT 4
RUN # 3
WIND: 090°/40 KNOTS
CURRENT: 050°/4.5 KNOTS
FAILURE CONDITION: ENGINE FAILURE
VISIBILITY: ½ MILE
51.20
50.40
49.60
48.80
48.00
47.20
46.40
45.60
44.80
44.00
-8.00
-7.20
-6.40
-5.60
-4.80
-4.00
-3.20
-2.40
-1.60
YD NAUT.MI.


4154 HAR01/6
RUN NO. 1
HARBOR: PUGETN
TEST SUBJECT 4
RUN # 4
WIND: 090°/40 KNOTS
CURRENT: 080°/2 KNOTS
FAILURE CONDITION: NONE
VISIBILITY: ½ MILE
42.80
42.40
42.00
41.60
41.20
40.80
40.40
40.00
39.60
39.20
-15.00
-14.60
-14.20
-13.80
-13.40
-13.00
-12.60
-12.20
-11.80
TO NAUT.MI.


4155 HAR02/4
RUN NO. 1
HARBOR: PUGETN
TEST SUBJECT 4
RUN # 5
WIND: 090°/40 KNOTS
CURRENT: 050°/4.5 KNOTS
FAILURE CONDITION: ENGINE FAILURE
VISIBILITY: ¼ MILE
XO NAUT.MI.
YO NAUT.MI.
51.20
50.40
49.60
48.80
48.00
47.20
46.40
45.60
44.80
44.00
-8.00
-7.20
-6.40
-5.60
-4.80
-4.00
-3.20
-2.40
-1.60


4156 ROS4
RUN NO. 1
HARBOR: PUGETN
TEST SUBJECT 4
RUN # 6
WIND: 090°/40 KNOTS
CURRENT: 020°/3.3 KNOTS
FAILURE CONDITION: NONE
VISIBILITY: ¼ MILE
45.25
44.00
42.75
41.50
40.25
39.00
37.75
36.50
35.25
34.00
2.00
3.25
4.50
5.75
7.00
8.25
9.50
10.75
12.00
YO NAUT.MI.


4160 HARB1/4
RUN NO. 1
HARBOR: PUGETN
TEST SUBJECT 4
WIND: 090°/40 KNOTS
CURRENT: 030°/2 KNOTS
FAILURE CONDITION: NONE
VISIBILITY: ¼ MILE
42.80
42.40
42.00
41.60
41.20
40.80
40.40
40.00
39.60
39.20
-15.00
-14.60
-14.20
-13.80
-13.40
-13.00
-12.60
-12.20
-11.80
YD NAUT.MI.


4162 AOS4T
RUN NO. 1
HARBOR: PUGETN
TEST SUBJECT 4
RUN # 8
WIND: 090°/40 KNOTS
CURRENT: 050°/4.5 KNOTS
FAILURE CONDITION: RUDDER AND ENGINE FAILURE
VISIBILITY: ½ MILE
45.25
44.00
42.75
41.50
40.25
39.00
37.75
36.50
35.25
34.00
2.00
3.25
4.50
5.75
7.00
8.25
9.50
10.75
12.00
YD NAUT.MI.

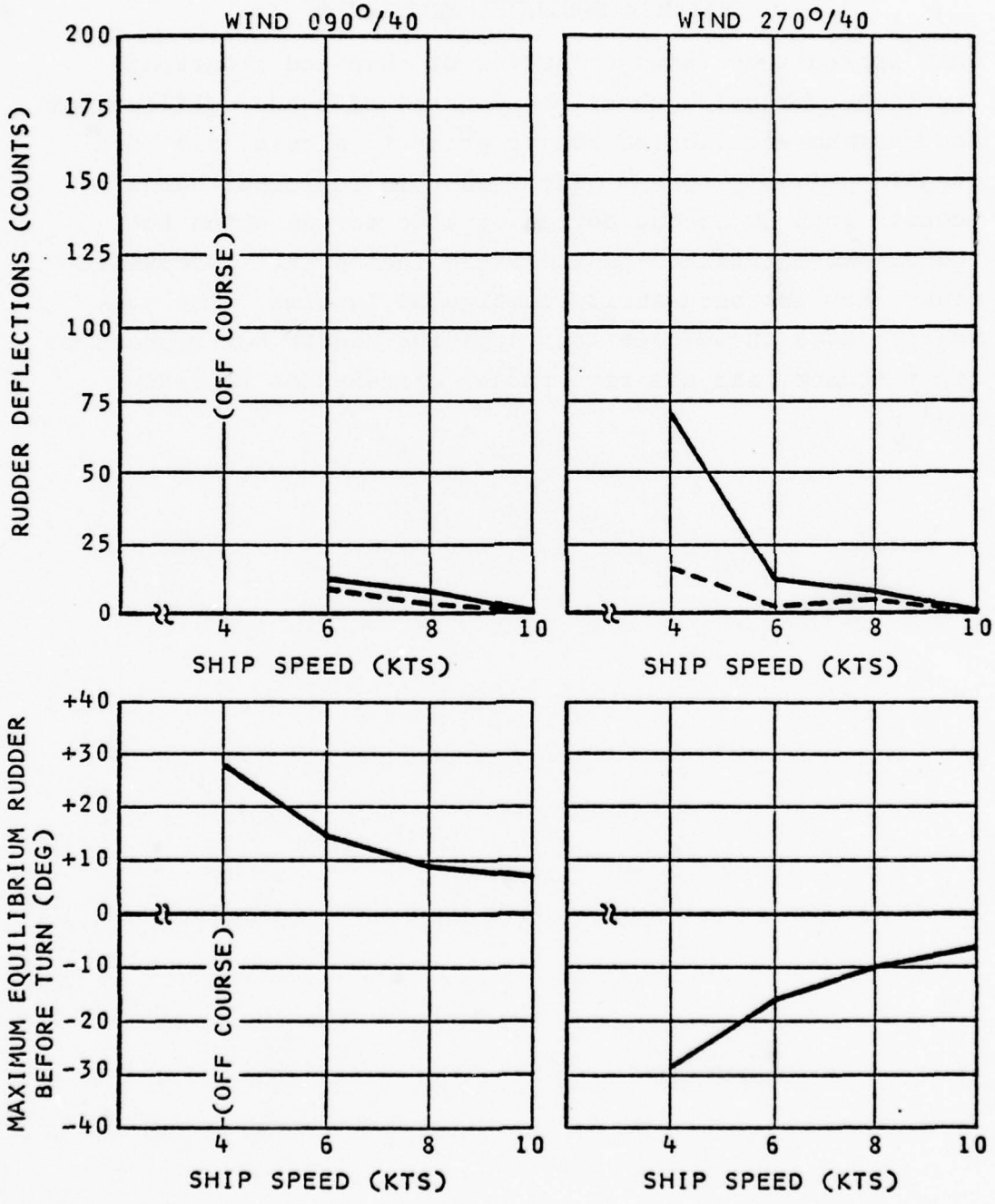
APPENDIX F

OFF-LINE TRACK KEEPING RUDDER DEFLECTION COUNTS AND MAXIMUM EQUILIBRIUM RUDDERS

This appendix contains a listing by ship and geographic location of the frequency (by counts) of rudder deflections, and maximum equilibrium rudder prior to a turn, all as a function of ship speed. The reader is reminded that a "count" is a 30 second period of time during which the rudder was maintained in the range indicated. Successive counts are not necessarily contiguous in time. The convention used throughout is: negative rudder corresponds to right rudder, and positive rudder corresponds to left rudder.

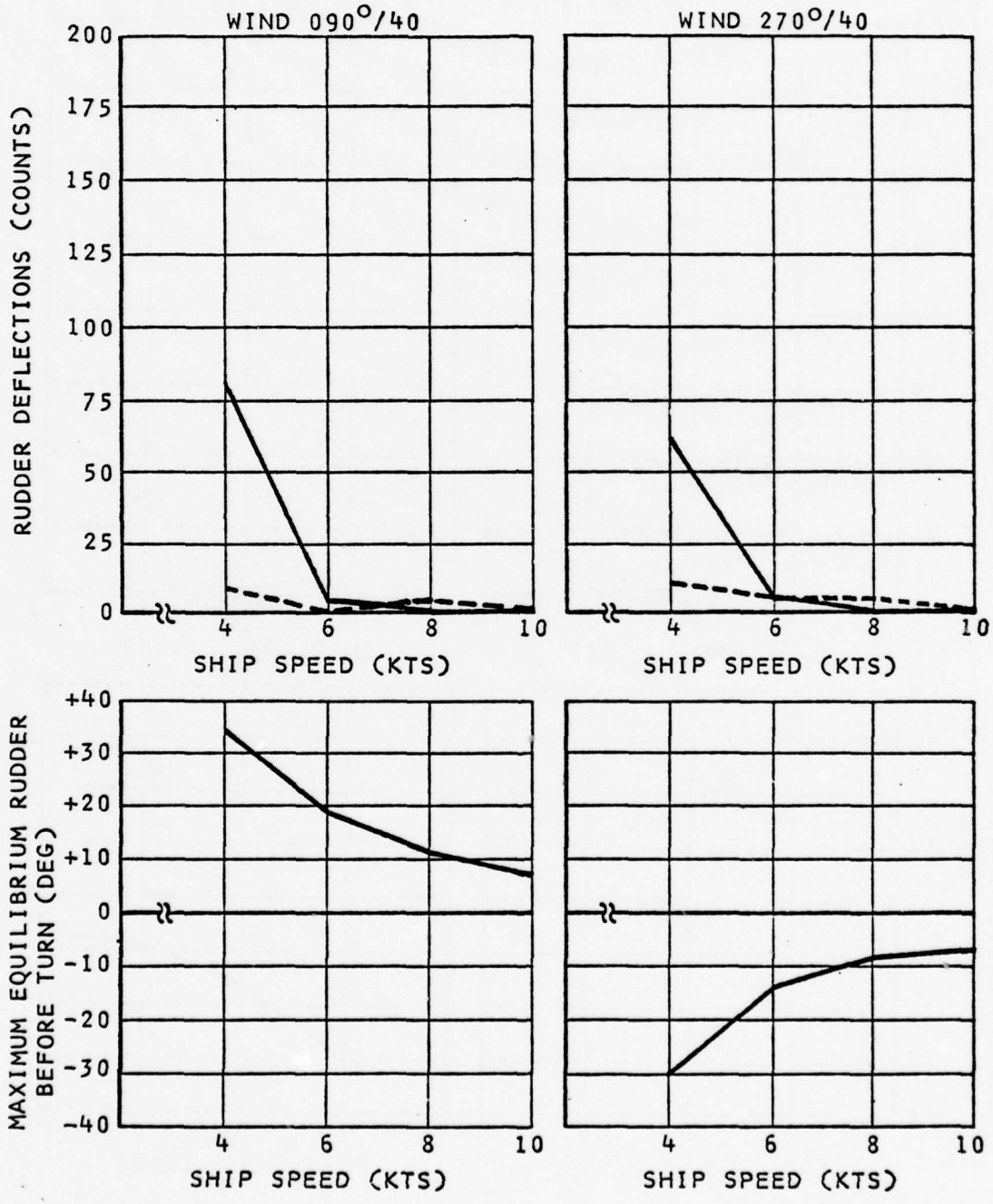
RUN DESCRIPTION:
SHIP 80,000 DWT
LOCATION ROSARIO STRAIT

RUDDER ANGLES
- - - - 20° TO 27½°
——— 27½° TO 35°



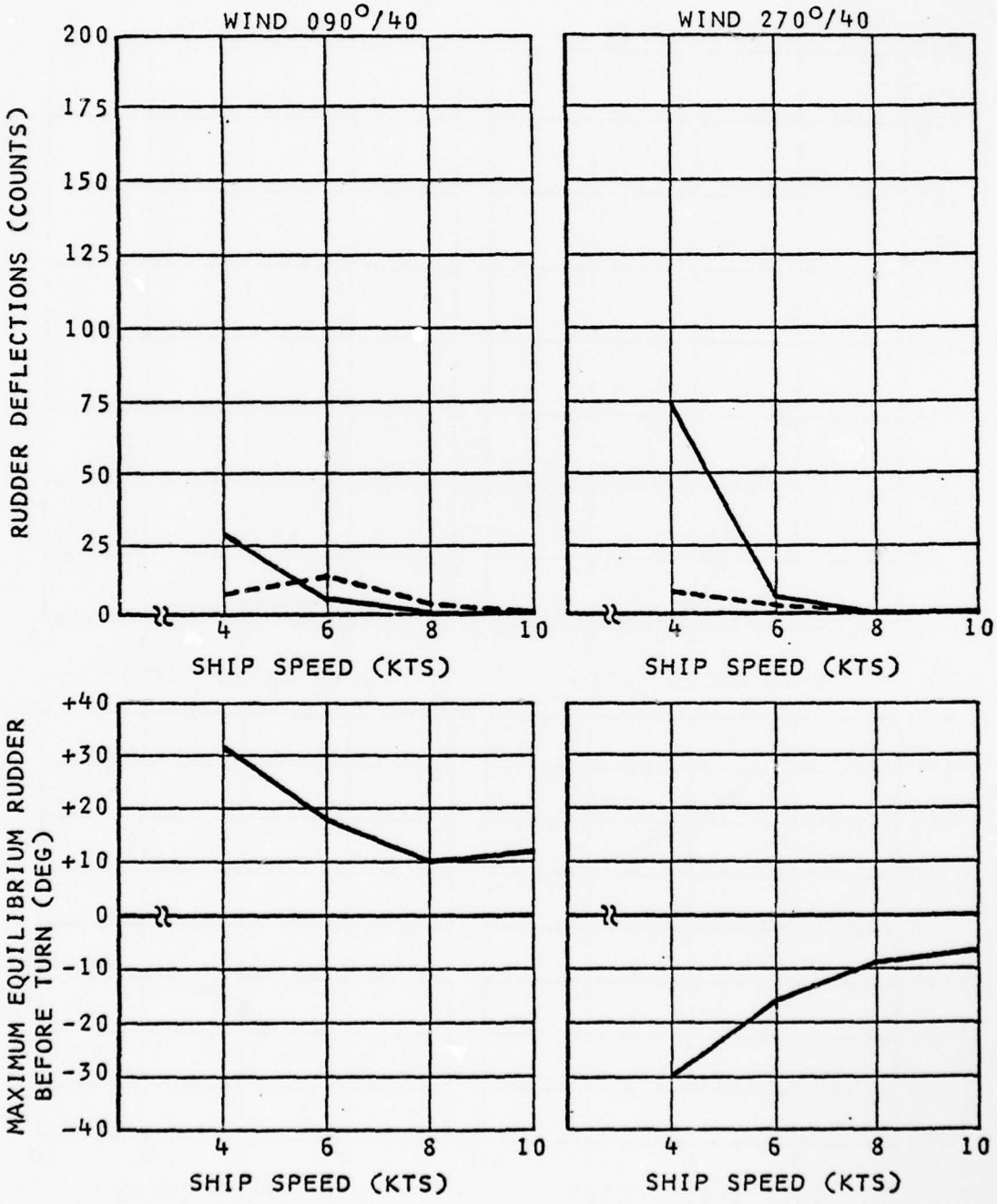
RUN DESCRIPTION:
SHIP 120,000 DWT
LOCATION ROSARIO STRAIT

RUDDER ANGLES
- - - - 20° TO 27½°
——— 27½° TO 35°



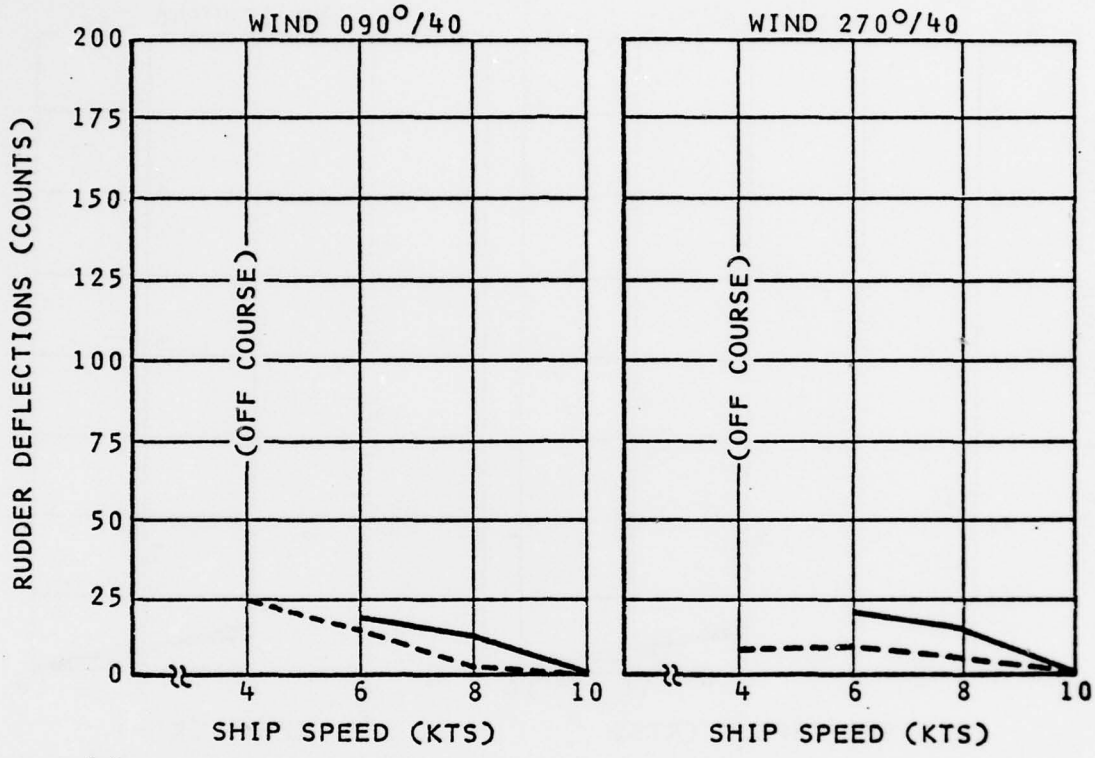
RUN DESCRIPTION:
SHIP 165,000 DWT
LOCATION ROSARIO STRAIT

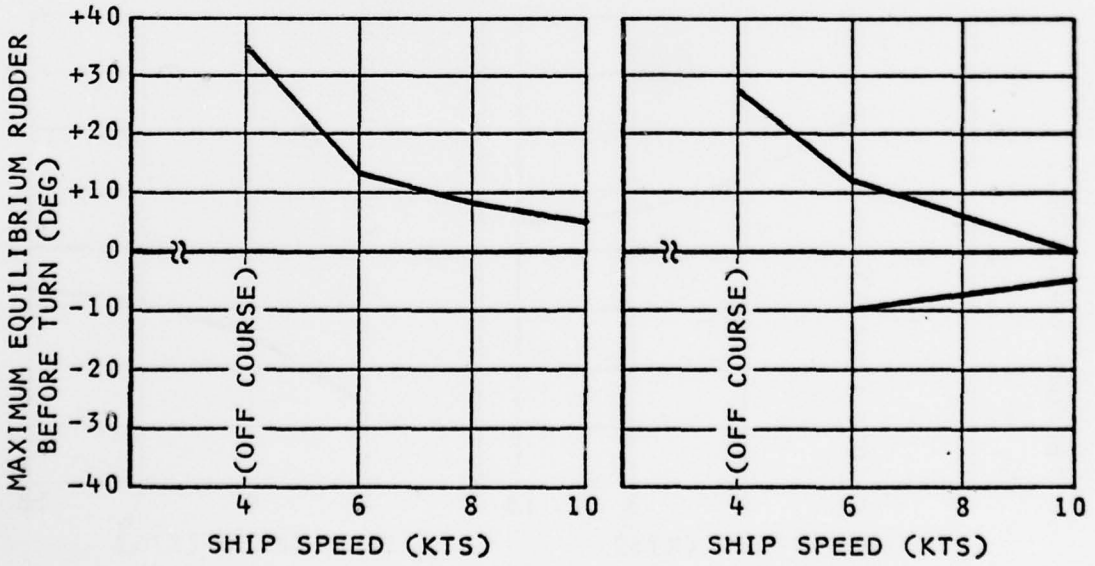
RUDDER ANGLES
- - - - 20° TO 27½°
——— 27½° TO 35°



RUN DESCRIPTION:
SHIP 280,000 DWT
LOCATION ROSARIO STRAIT

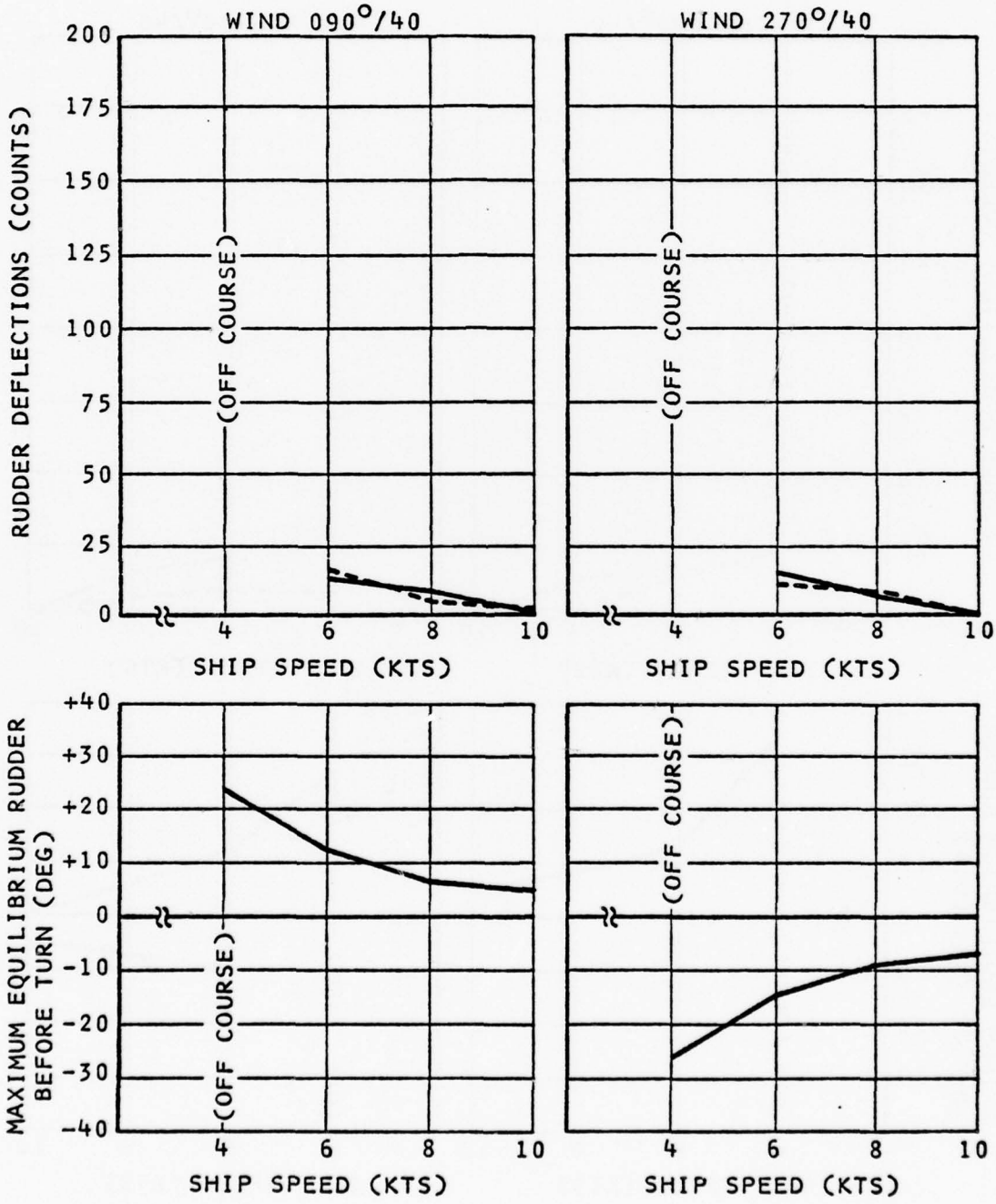
RUDDER ANGLES
- - - - 20° TO 27½°
——— 27½° TO 35°





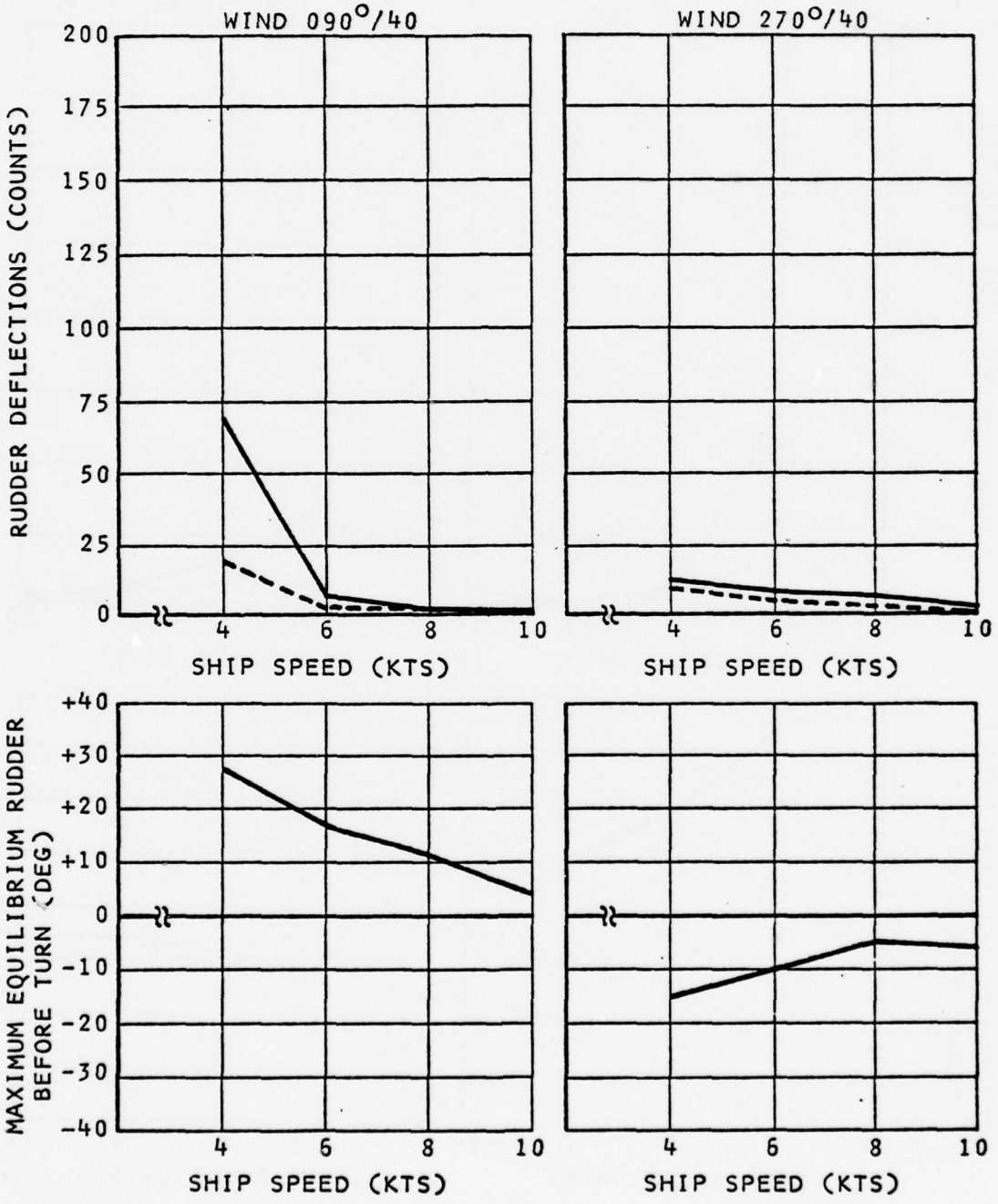
RUN DESCRIPTION:
SHIP 400,000 DWT
LOCATION ROSARIO STRAIT

RUDDER ANGLES
- - - - 20° TO 27½°
——— 27½° TO 35°



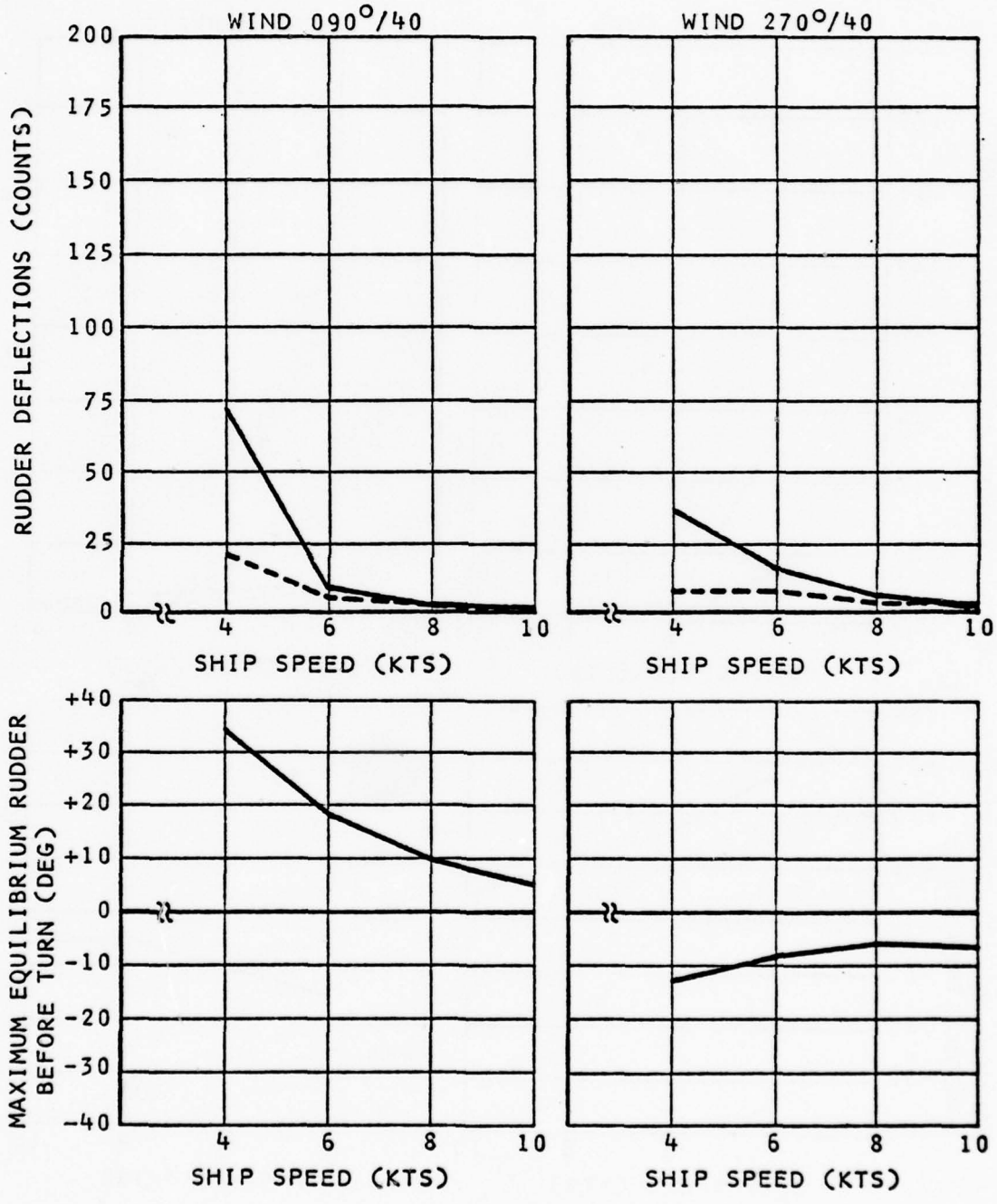
RUN DESCRIPTION:
SHIP 120,000 DWT
LOCATION HARO STRAIT

RUDDER ANGLES
- - - - 20° TO 27½°
——— 27½° TO 35°



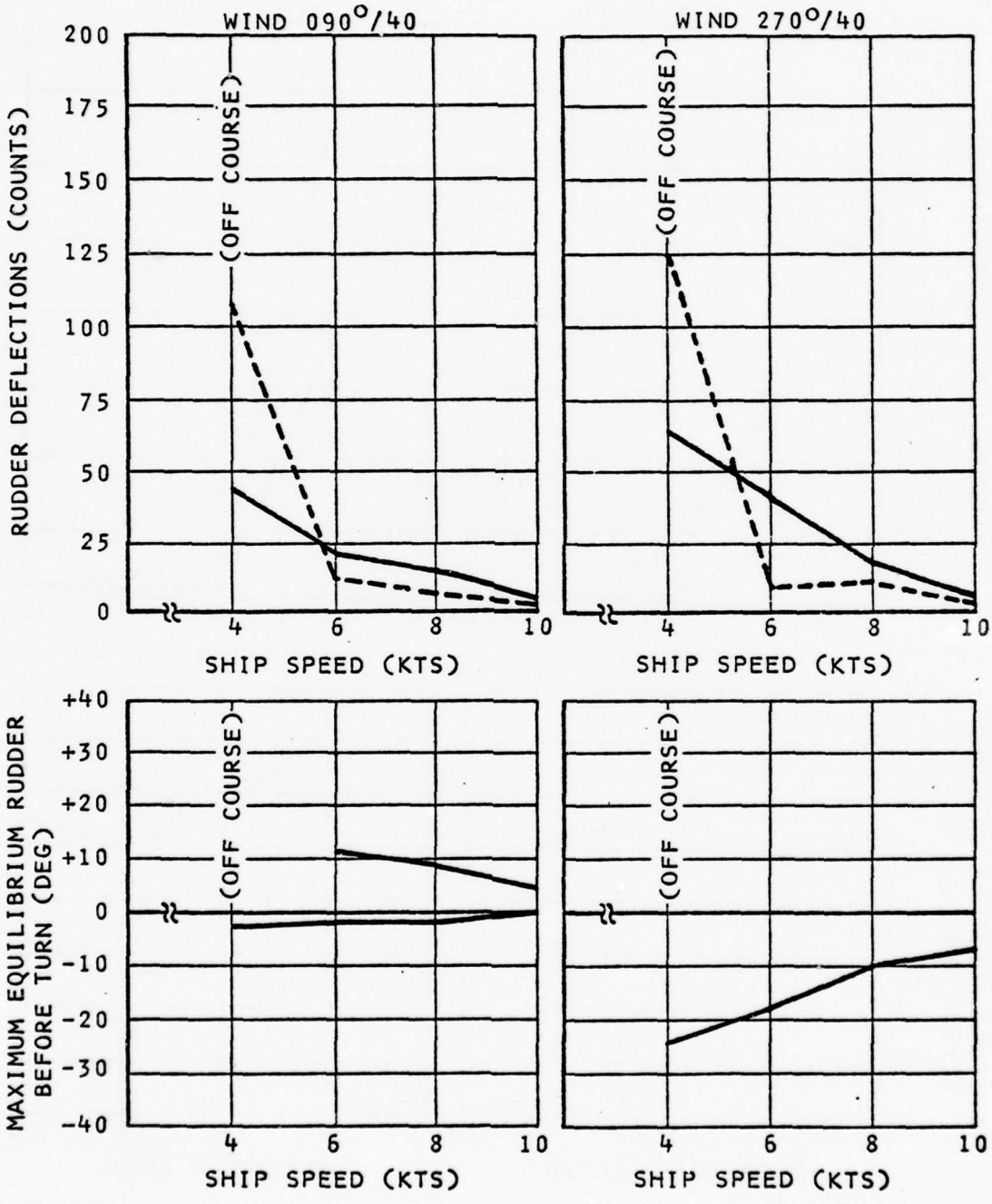
RUN DESCRIPTION:
SHIP 165,000 DWT
LOCATION HARO STRAIT

RUDDER ANGLES
- - - - 20° TO 27½°
——— 27½° TO 35°



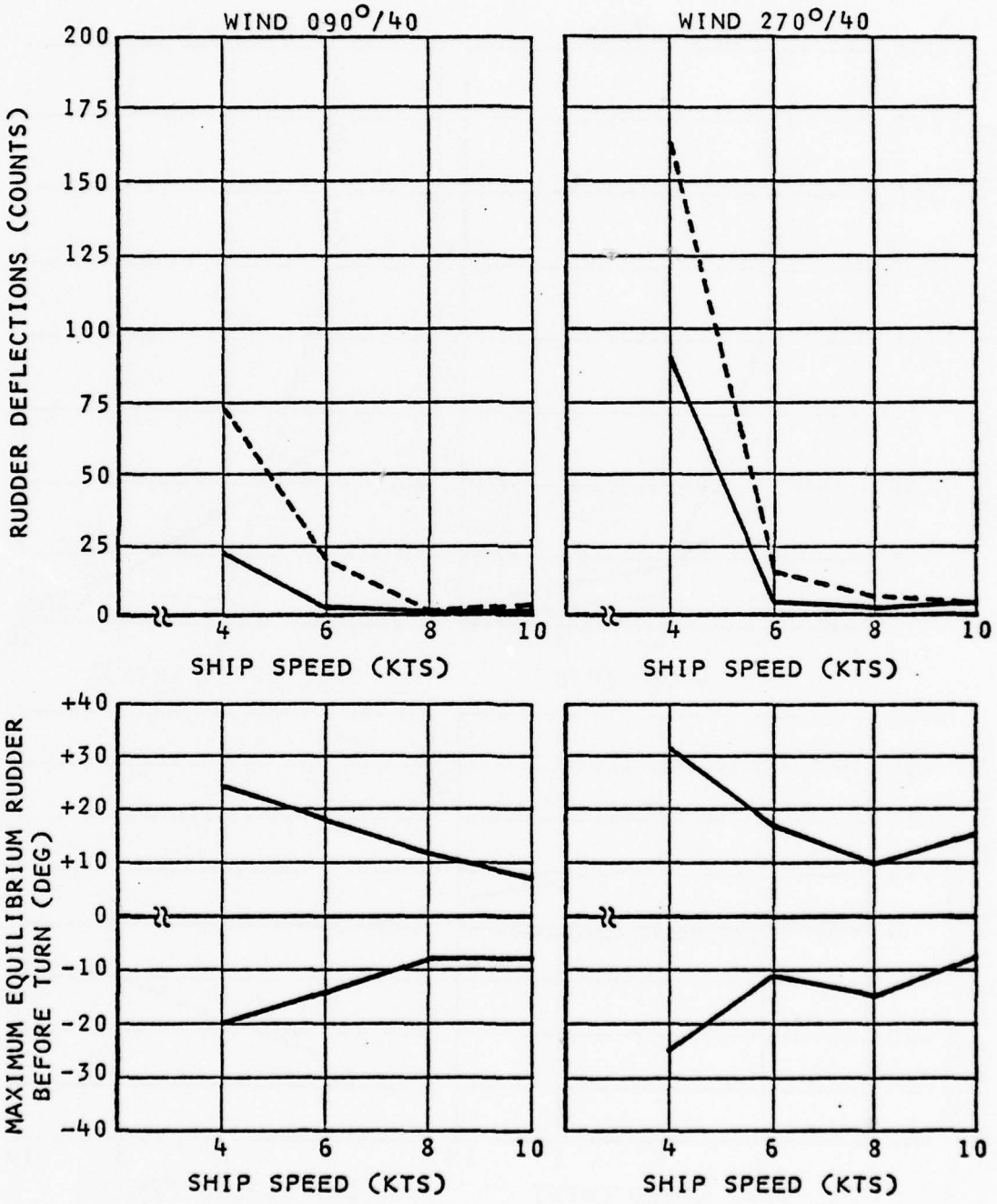
RUN DESCRIPTION:
SHIP 400,000 DWT
LOCATION HARO STRAIT

RUDDER ANGLES
- - - - 20° TO 27½°
——— 27½° TO 35°



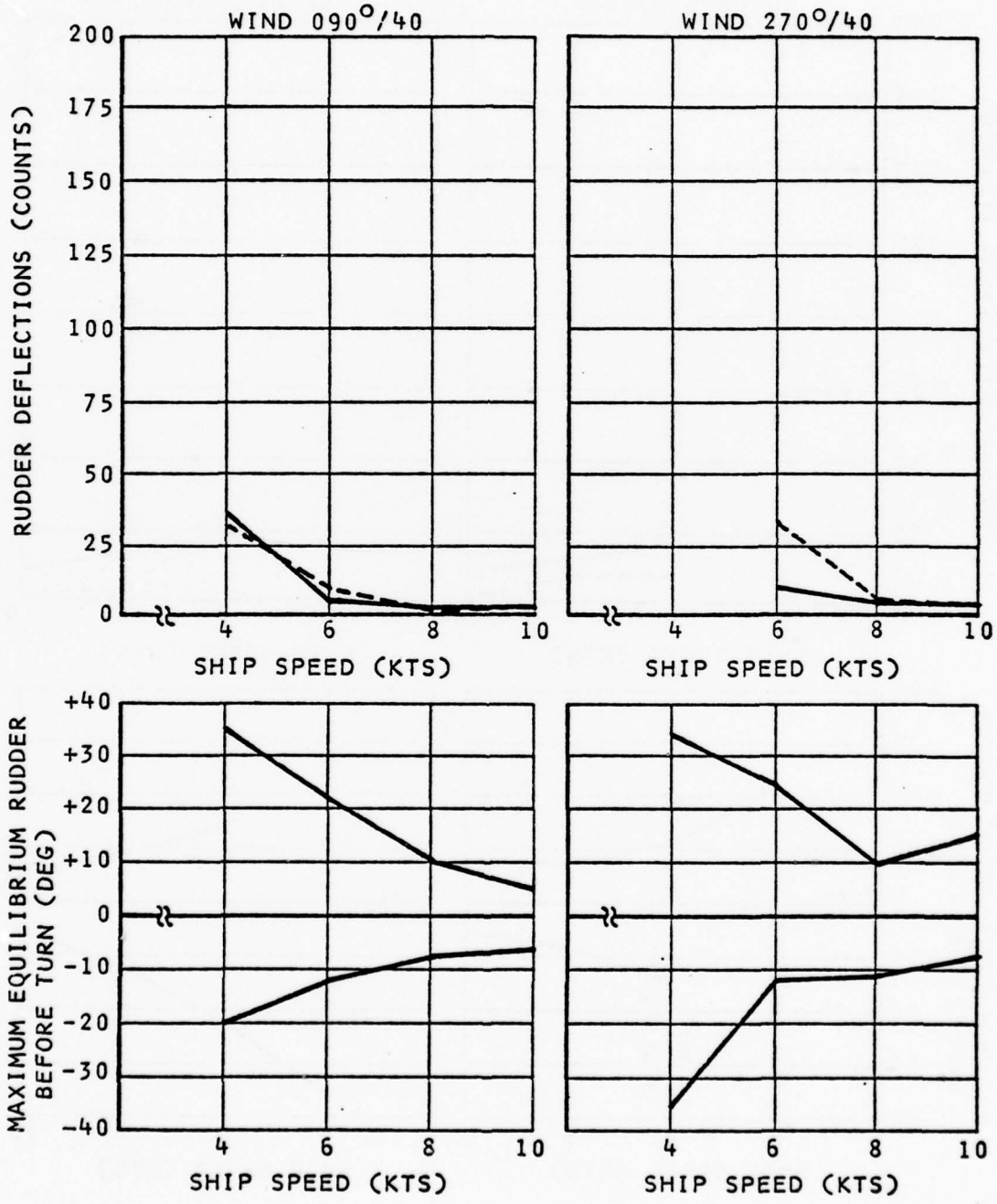
RUN DESCRIPTION:
SHIP 120,000 DWT
LOCATION BELLINGHAM CHANNEL

RUDDER ANGLES
- - - - 20° TO 27½°
——— 27½° TO 35°



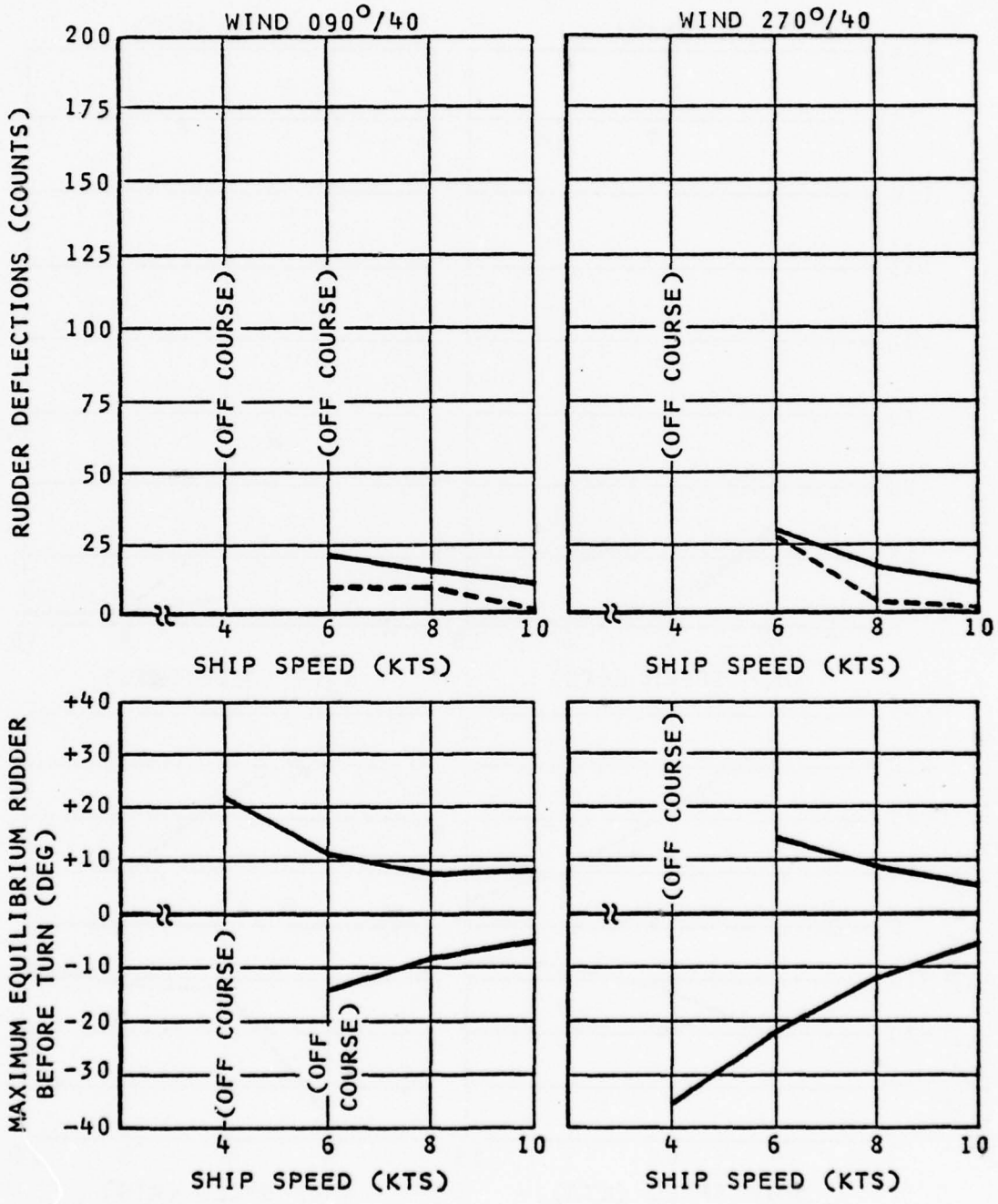
RUN DESCRIPTION:
SHIP 165,000 DWT
LOCATION BELLINGHAM CHANNEL

RUDDER ANGLES
- - - - 20° TO 27½°
——— 27½° TO 35°



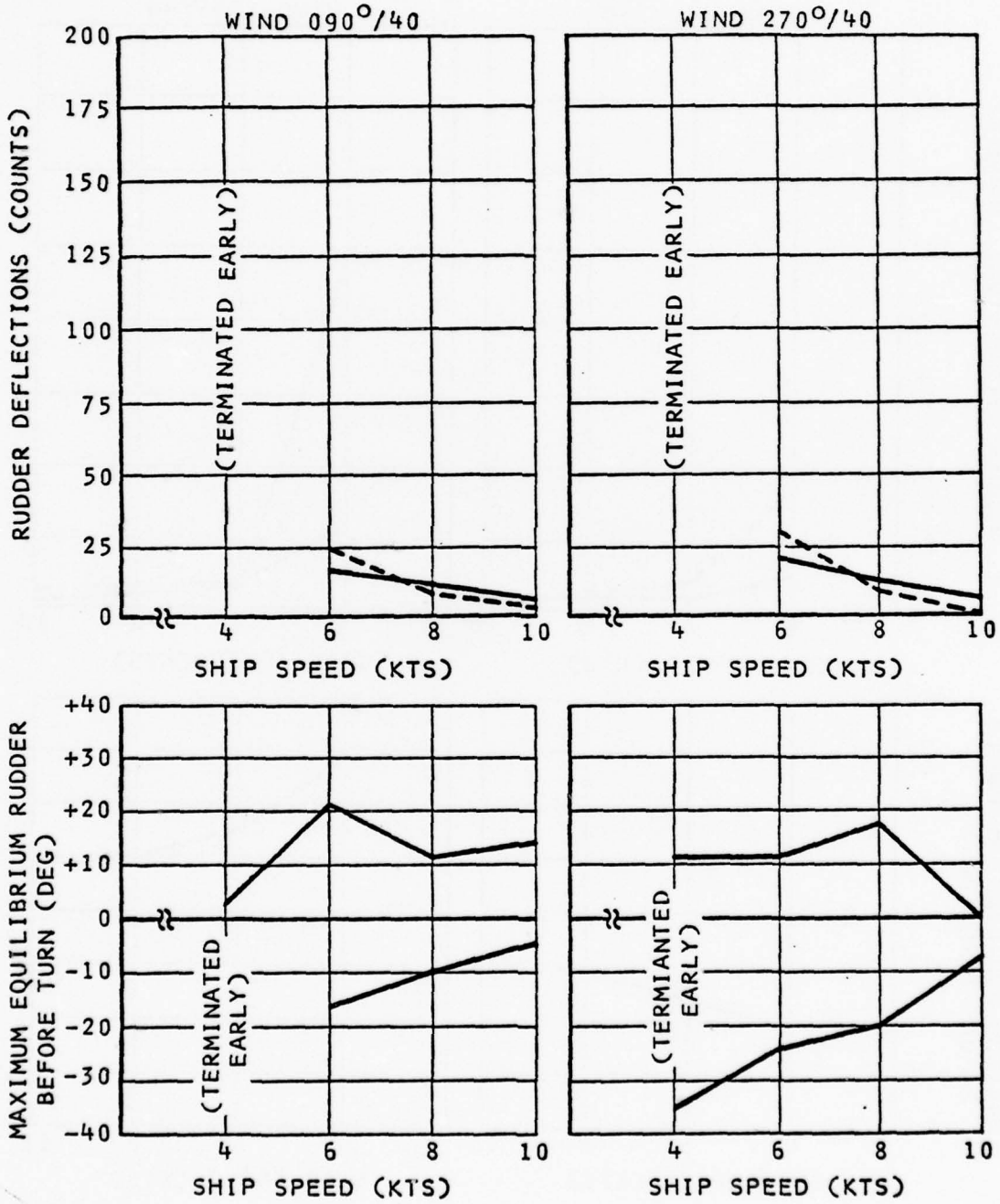
RUN DESCRIPTION:
SHIP 280,000 DWT
LOCATION BELLINGHAM CHANNEL

RUDDER ANGLES
- - - - 20° TO 27½°
——— 27½° TO 35°



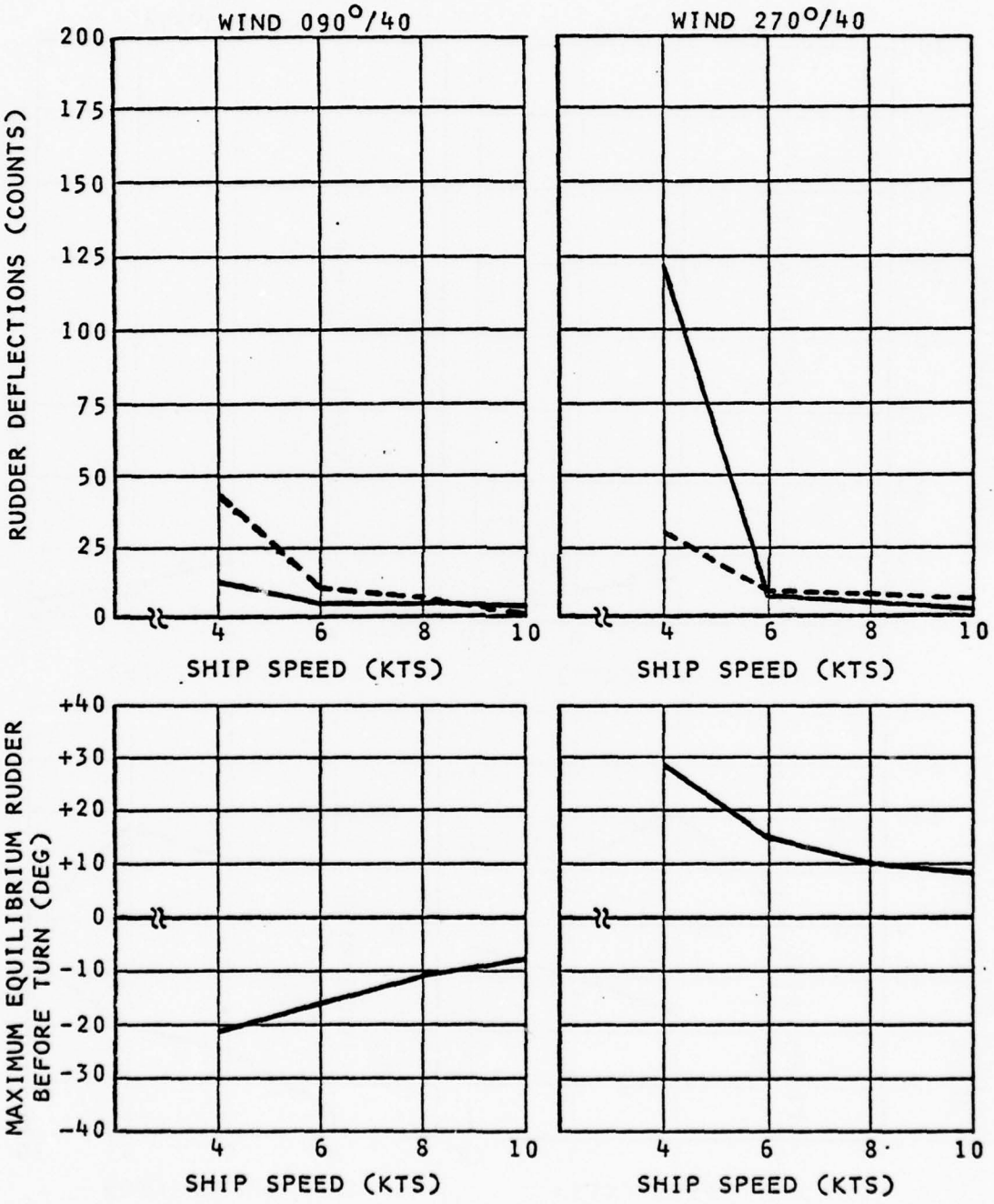
RUN DESCRIPTION:
SHIP 400,000 DWT
LOCATION BELLINGHAM CHANNEL

RUDDER ANGLES
- - - - 20° TO 27½°
——— 27½° TO 35°



RUN DESCRIPTION:
SHIP 120,000 DWT
LOCATION ADMIRALTY INLET

RUDDER ANGLES
---- 20° TO 27½°
——— 27½° TO 35°

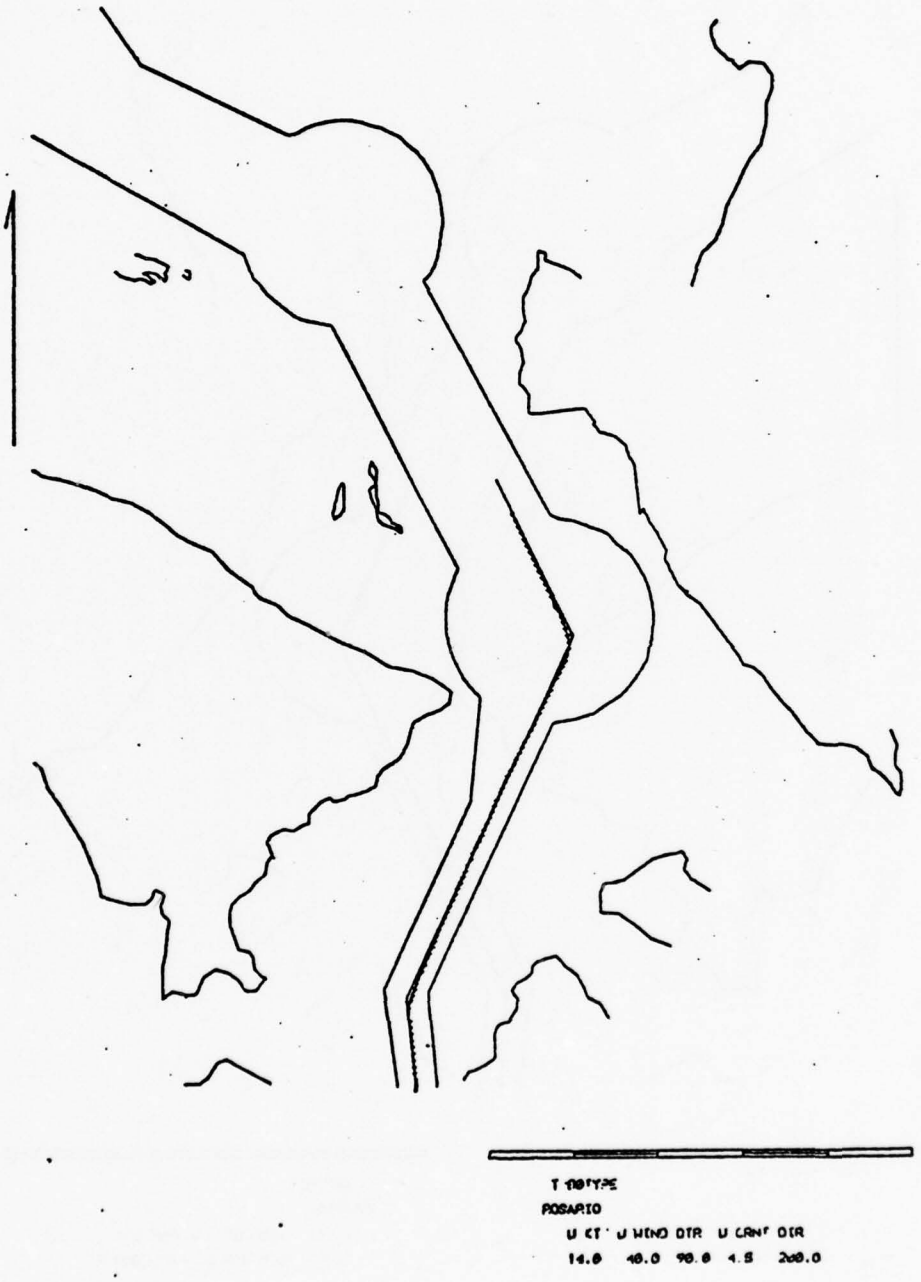


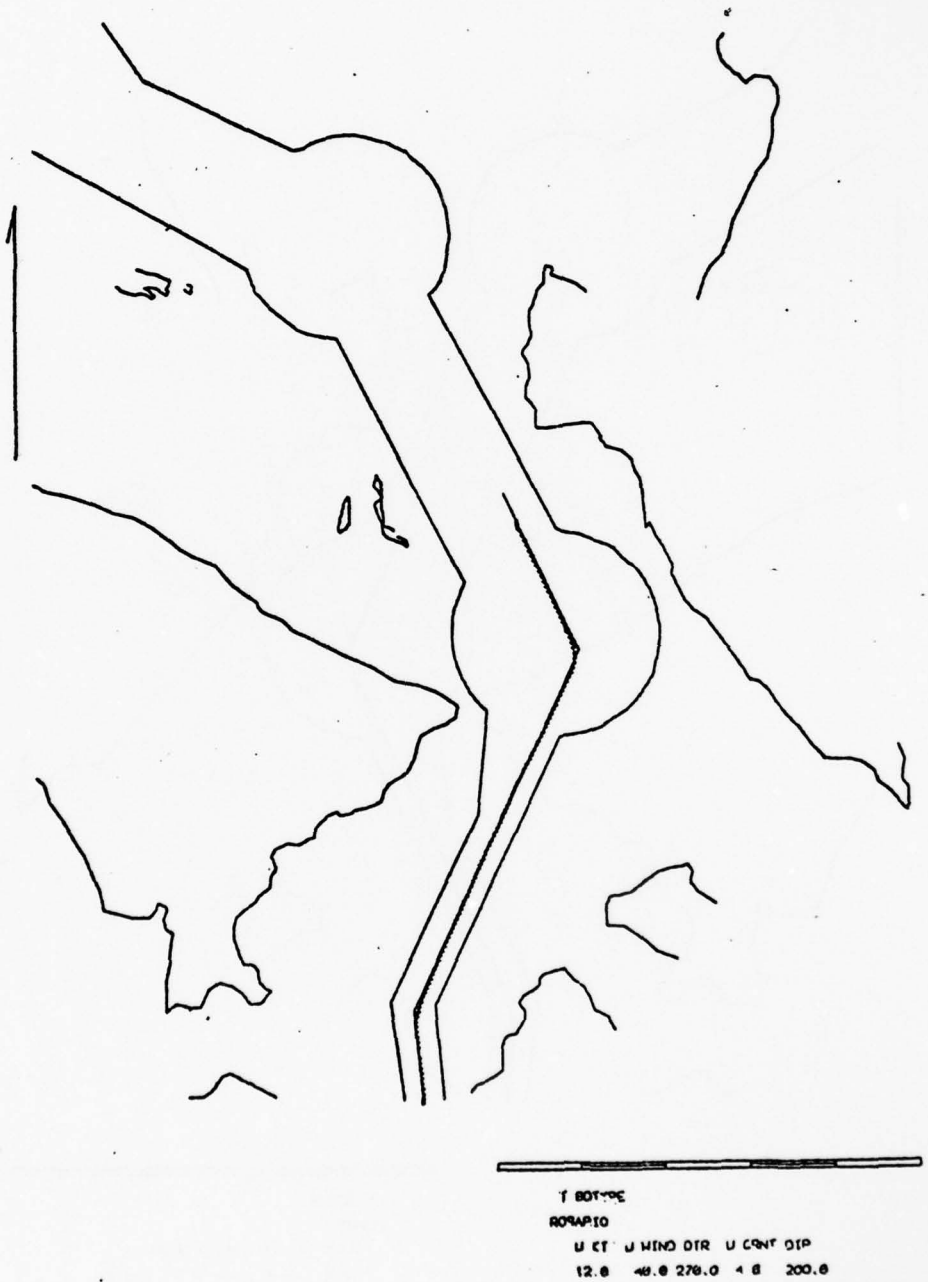
APPENDIX G

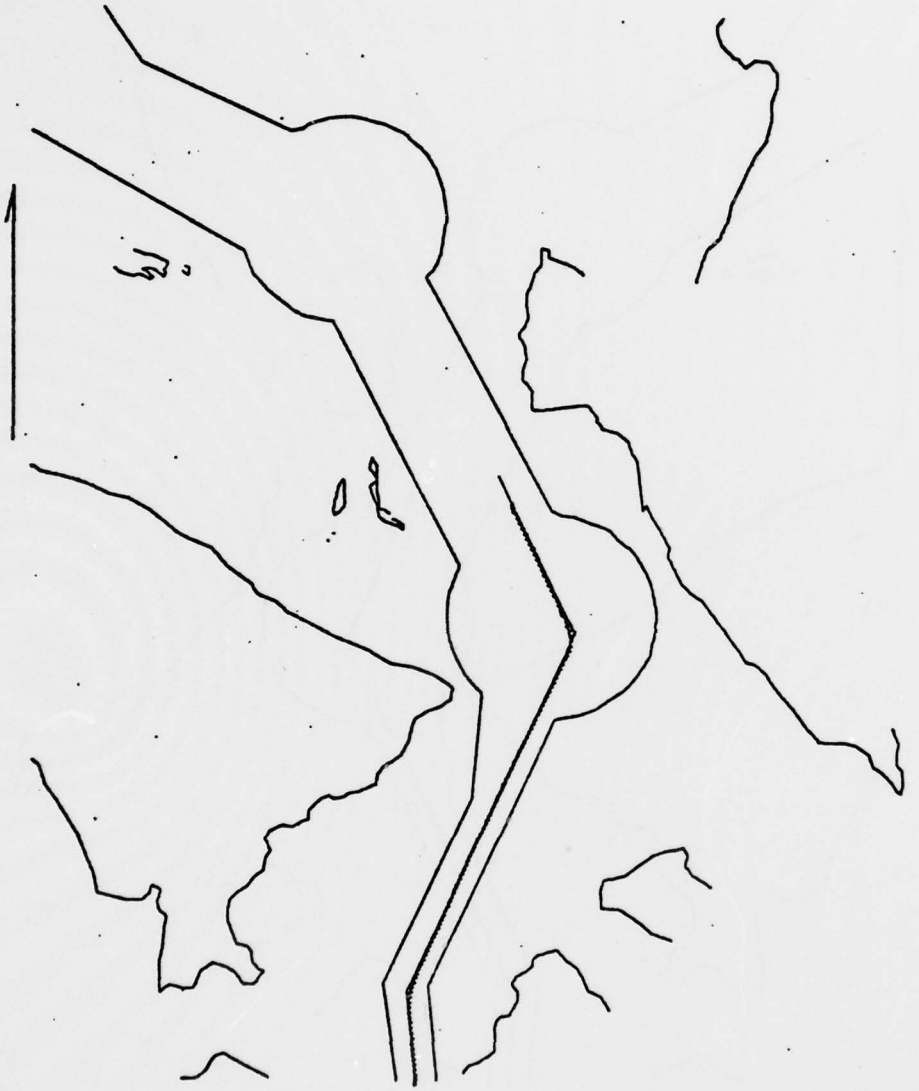
PLOTS OF OFF-LINE TRACK KEEPING RUNS

This appendix contains the plots of all ground tracks made by ships off-line under the control of an autopilot.

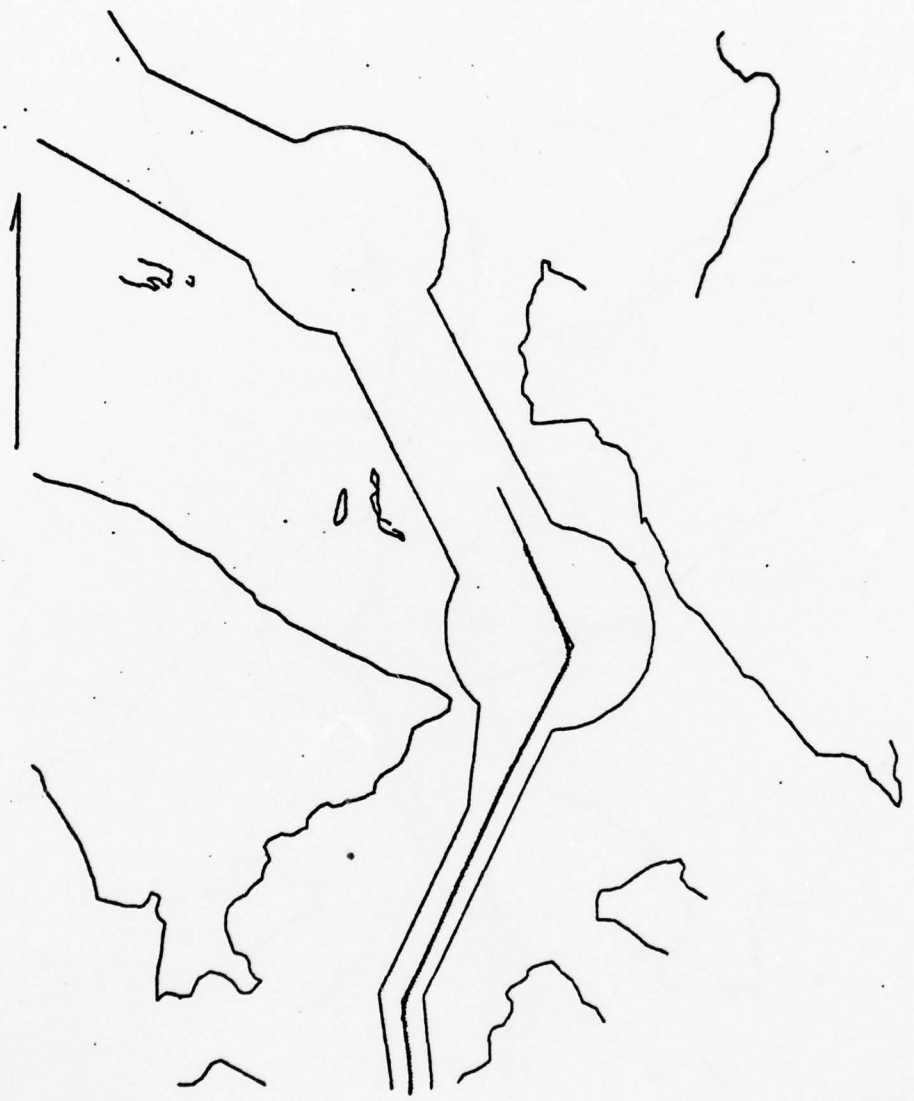
T 80TYPE
ROPARID
U KT U WIND DIR U CONT DIR
14.8 40.0 270.8 4.8 270.8


T TRFTYPE
ROSARIO
U KT U WIND DIR U CRNT DIR
14.0 40.0 90.0 4.5 200.0


T BOTTOM
ROMAPIO
U ET U WIND DIR U CONT DIP
12.8 49.8 270.0 4.8 200.8

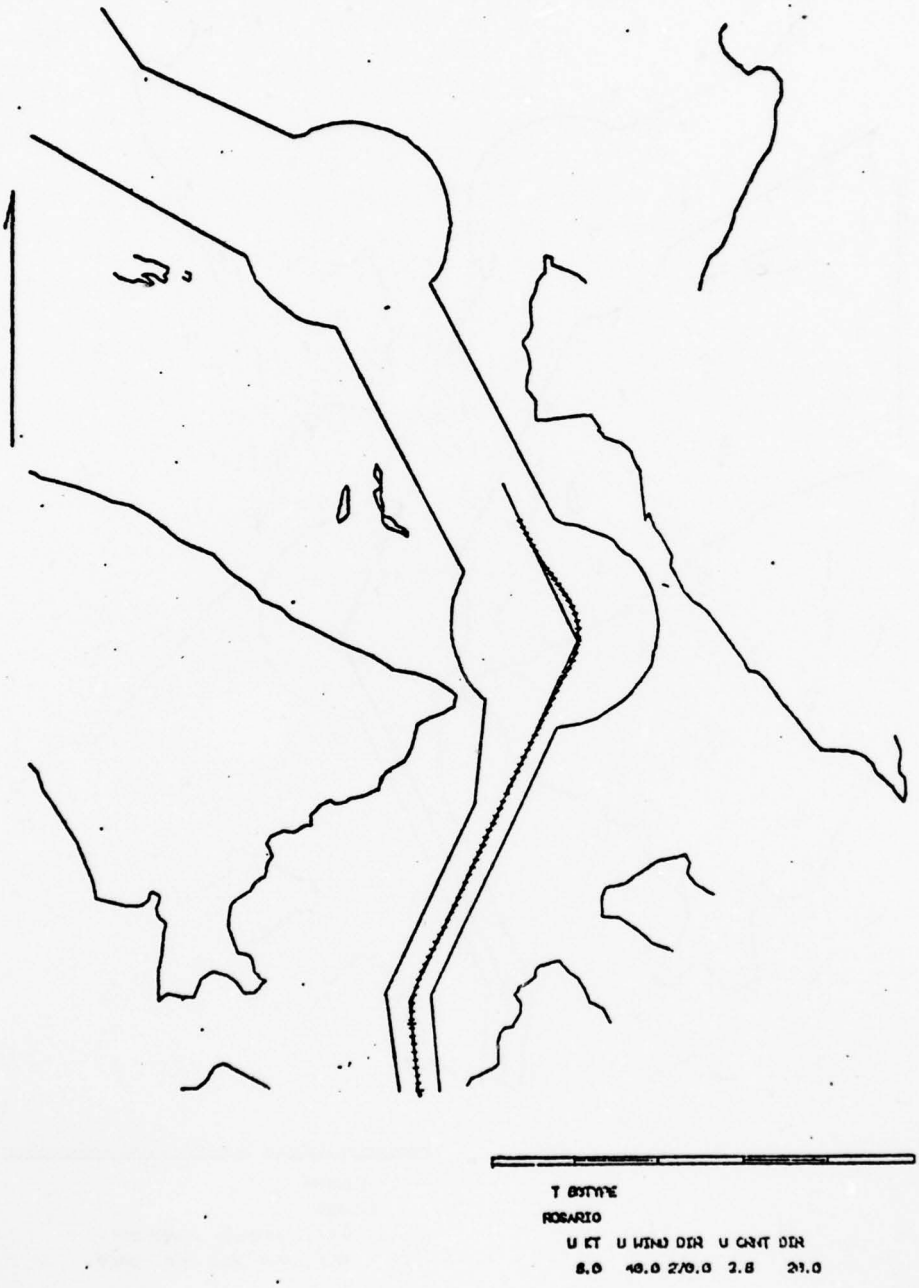


T 88F,°C
RO'ARIO
U CF U WIND DIR U CRNT DIR
12.6 46.0 90.0 4.8 200.0



T 80 FTPS
ROMARIO
U ET U WIND DIR U CONT DIR
10.6 40.8 270.8 4.8 209.0

1 BOTTOM
ROSARIO
U EF U WIND DIR U CONT DIR
10.0 40.0 90.0 4.0 200.0


T 85TYPE
ROSARIO
U KT U WIND DIR U CRNT DIR
8.0 40.0 270.0 2.8 20.0

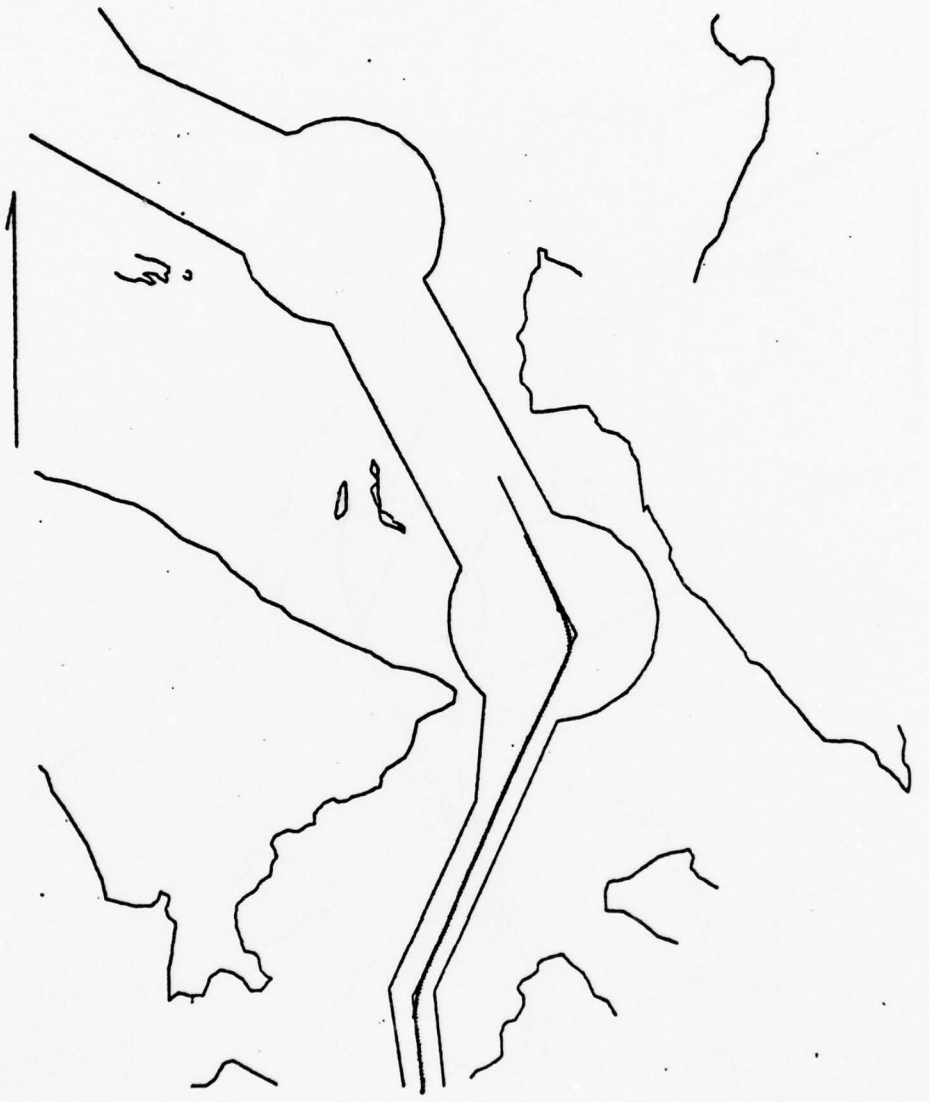

r BOTTPE
ROSARIO
U ET U WIND DIR U CONT DIR
8.0 40.0 90.0 3.8 20.0

T BOTTPE
PDPARIO
U CT U WIND DIR U CON DIR
6.0 48.0 278 0 3.8 2d.0


T DOTTPE
RORAPIO
U E1 U WIND DIP U CONF DIP
6.0 40.0 90.0 2.5 20.0

T ABTYPE
ROSARIO
U KT U WIND DIR U CRNT DIR
4.0 40.0 270.0 2.8 20.0

T BOTYPE
ROSARIO
U KT U WIND DIR U CRNT DIR
4.0 40.0 90.0 3.8 20.0



T 208TYPE
ROSARIO
U SPT U WIND DIR U CONT DIR
10.0 40.0 270.0 4.8 200.0

T 298TYPE
ROSARIO
U ET U WIND DIR U CONT IR
10.0 40.0 90.0 4.8 200.0

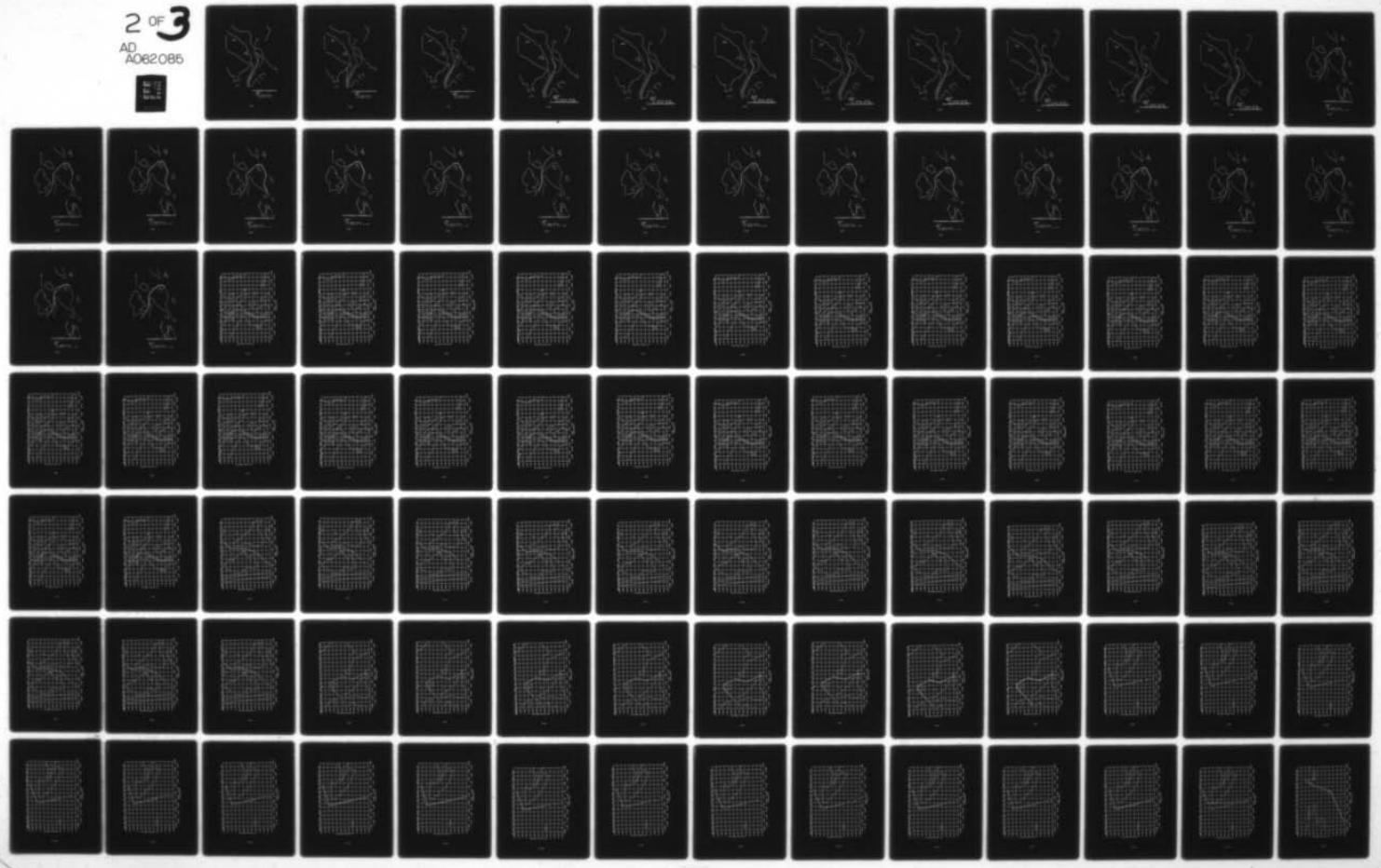
T 208TYPE
FORARIO
U ET U WIND DIR U CENT DIR
8.8 40.0 270.0 2.8 20.0

T 290TYPE
ROSARIO
U-ET U WIND DIR U CONT DIR
8.0 40.0 90.0 2.8 20.0


T 208TYPE
ROSARIO
U KT U WIND DIR U CRNT DIR
6.8 40.8 270.8 3.8 28.8

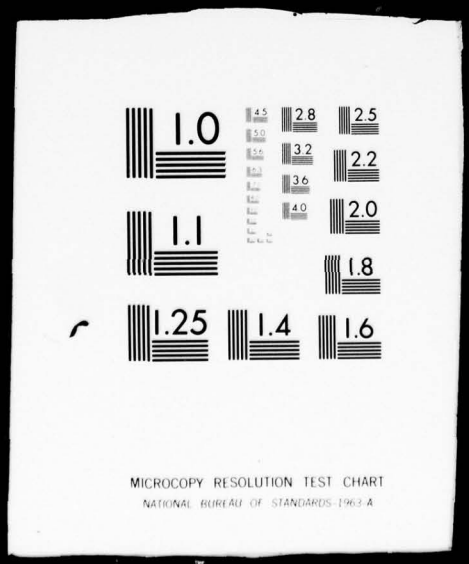
AD-A062 085 NATIONAL MARITIME RESEARCH CENTER KINGS POINT NY F/G 13/10
AN INVESTIGATION INTO SAFETY OF PASSAGE OF LARGE TANKERS IN THE--ETC(U)
OCT 78 J RIEK, S TENENBAUM, W MCILROY MIPR-Z70099-8-843822
UNCLASSIFIED USCG-D-79-78-APP-2 NL

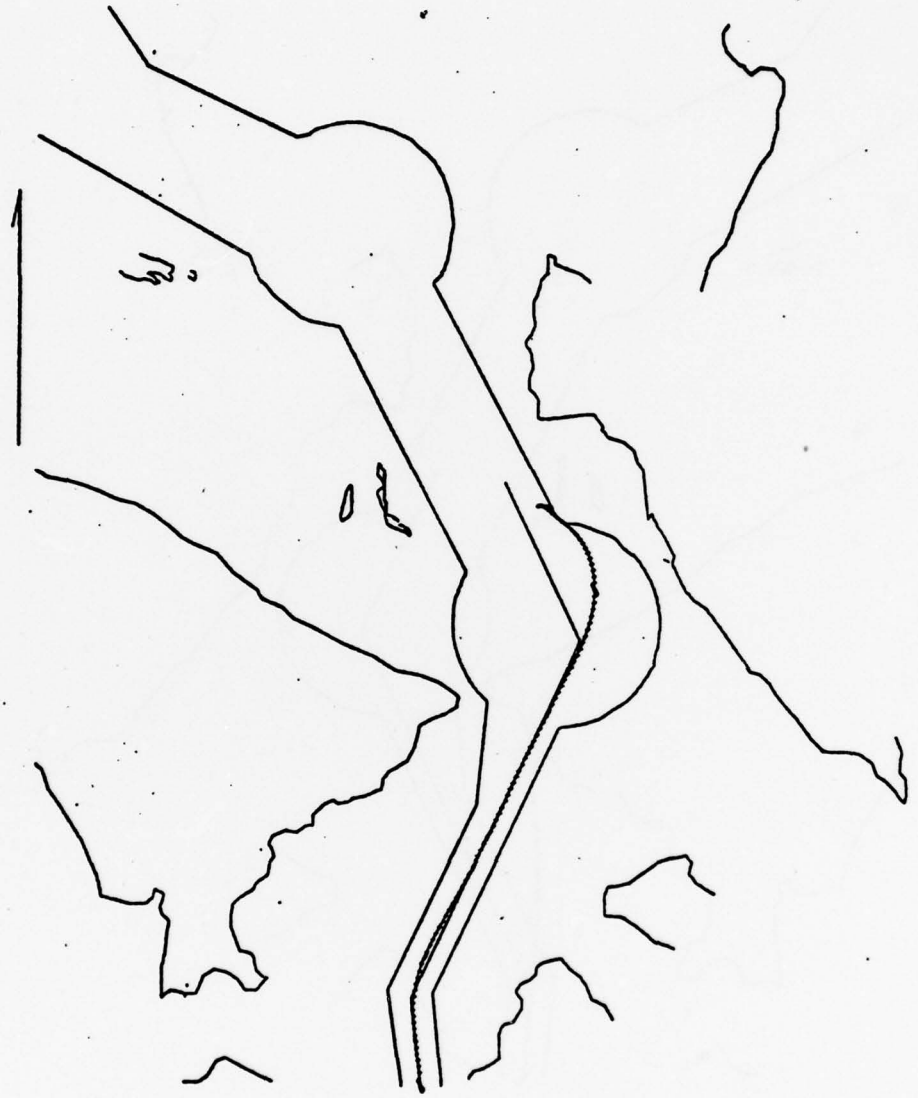
2 OF 3
AD A062085



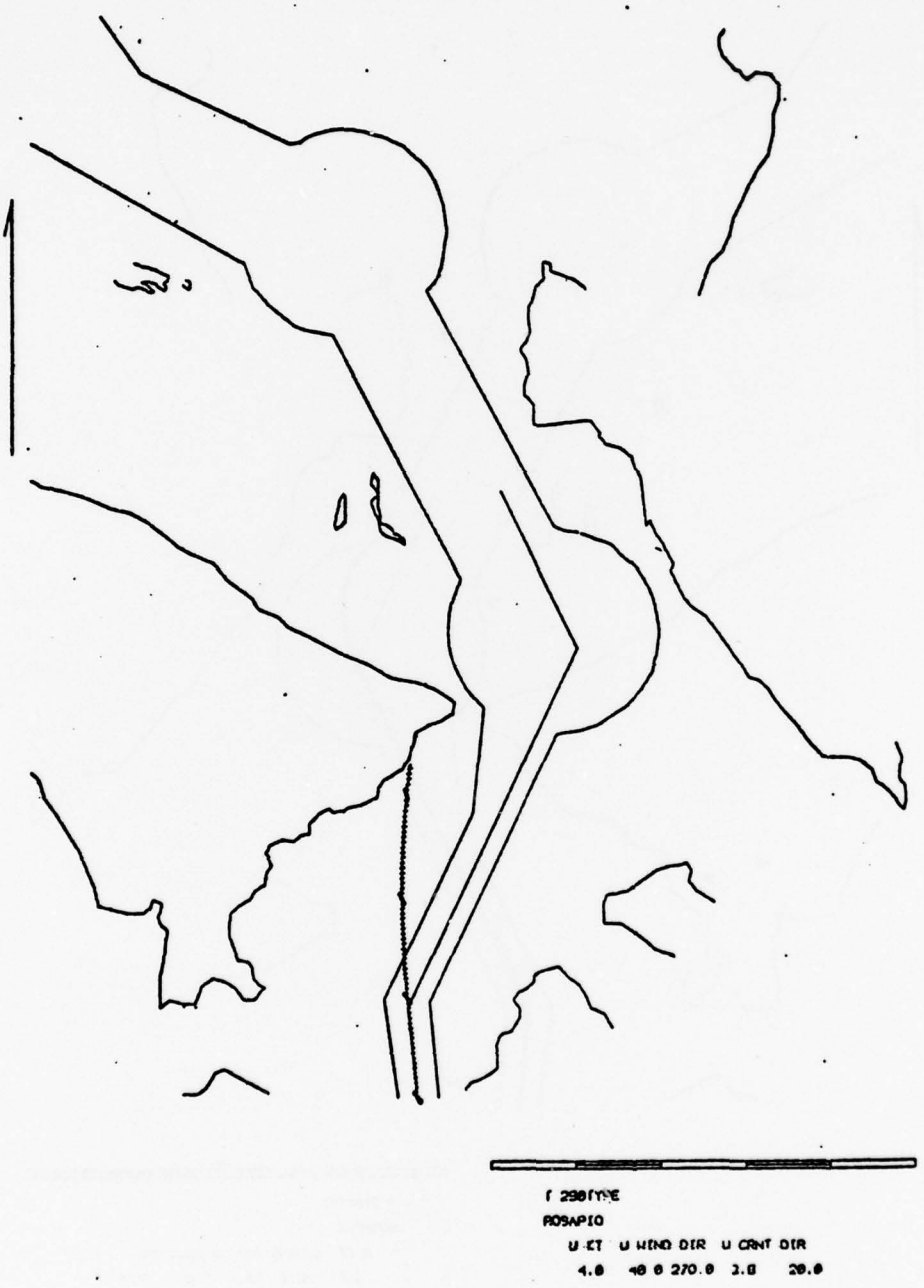
2 OF 3

AD
A062085

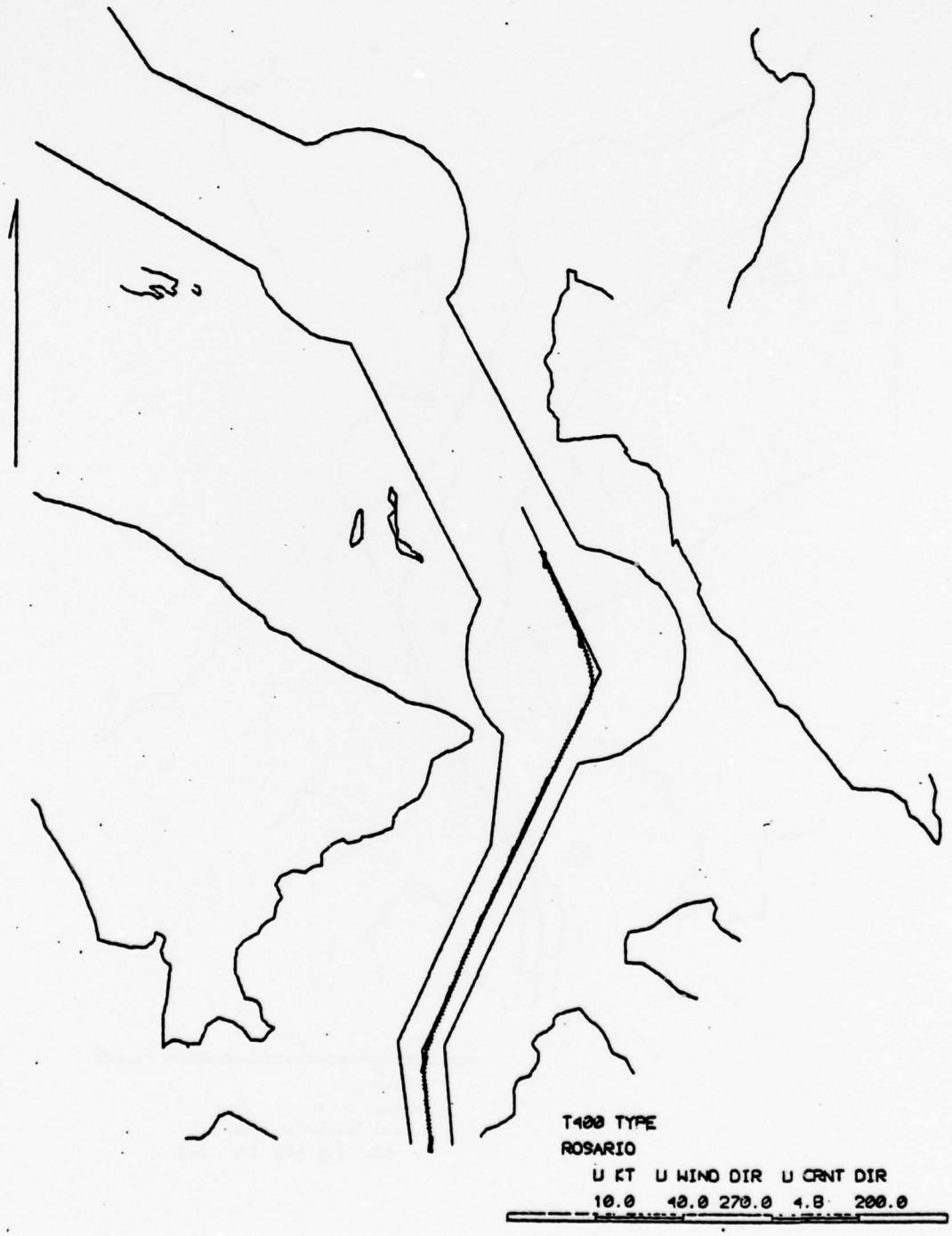


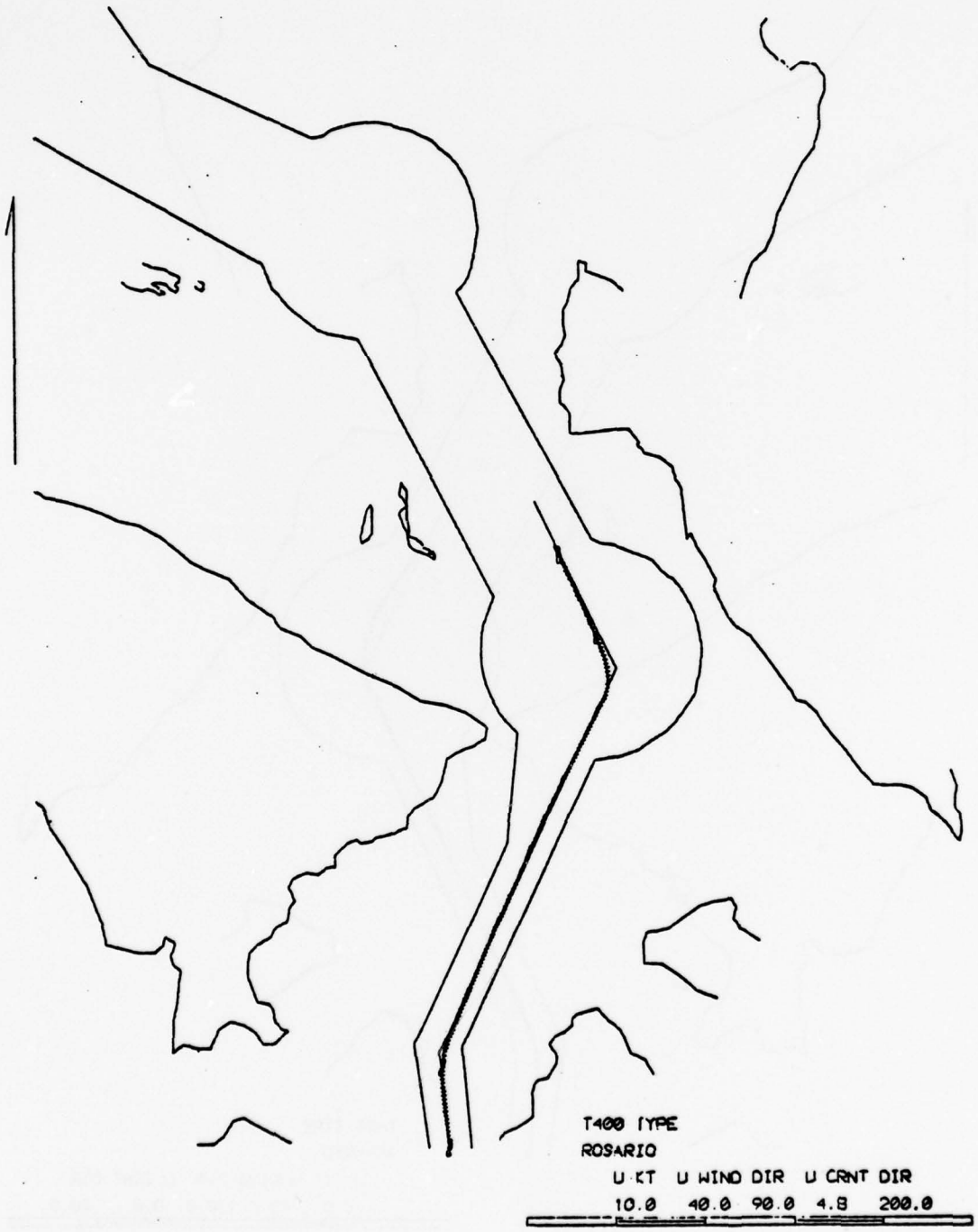


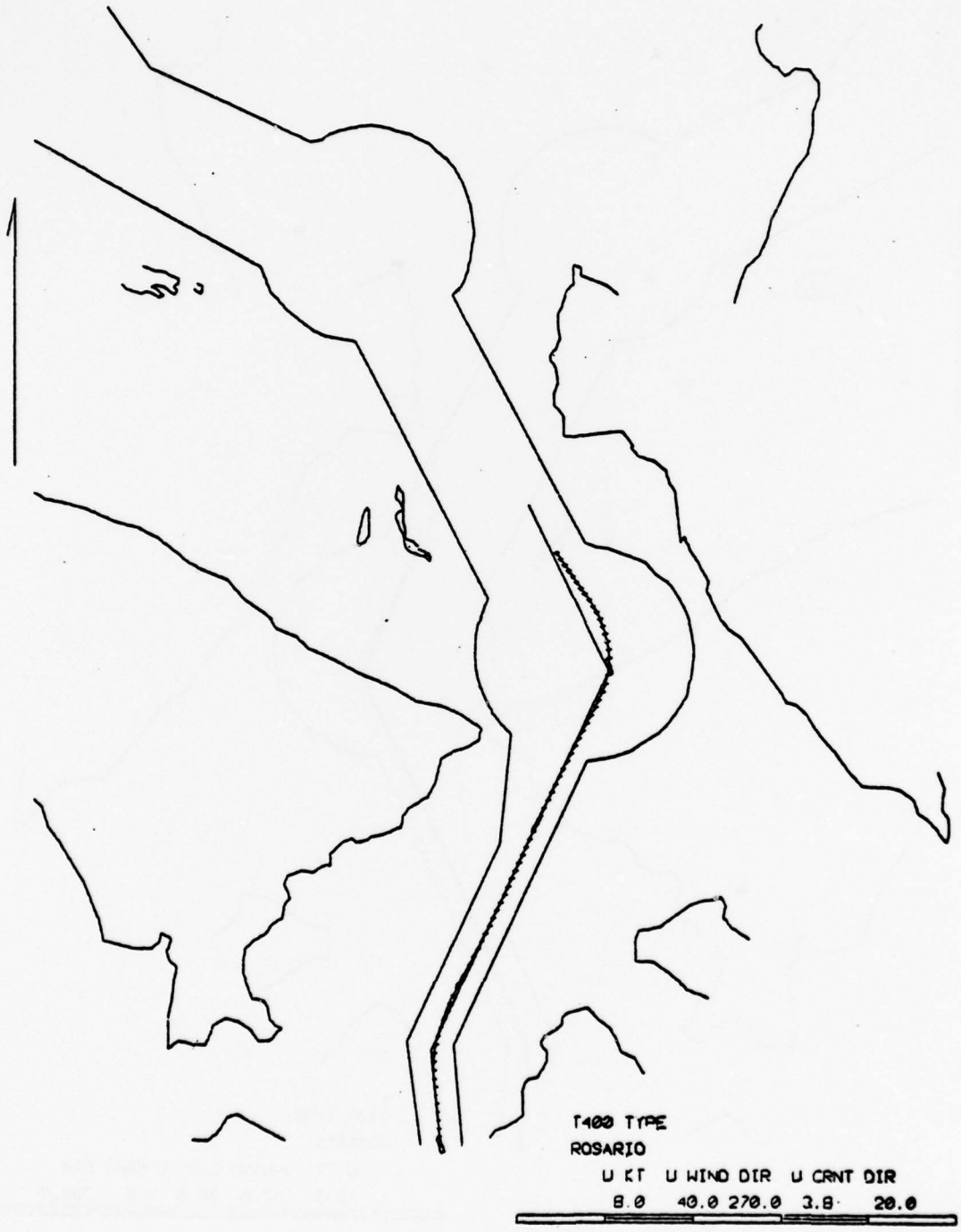
F 298TYPE
ROSARIO
U ET U WIND DIR U CRNT DIR
6.8 40.0 90.0 2.8 20.0


f 298TYPE
ROSAPIO
U-ET U WIND DIR U CRNT DIR
4.8 48 0 270.0 3.8 20.0

F 280TYPE
ROSARIO
U KT U WIND DIR U CRNT DIR
4.8 40.0 90.0 3.8 20.0


T400 TYPE
ROSARIO
U KT U WIND DIR U CRNT DIR
10.0 40.0 270.0 4.8 200.0


T400 TYPE
ROSARIO
U KT U WIND DIR U CRNT DIR
10.0 40.0 90.0 4.8 200.0

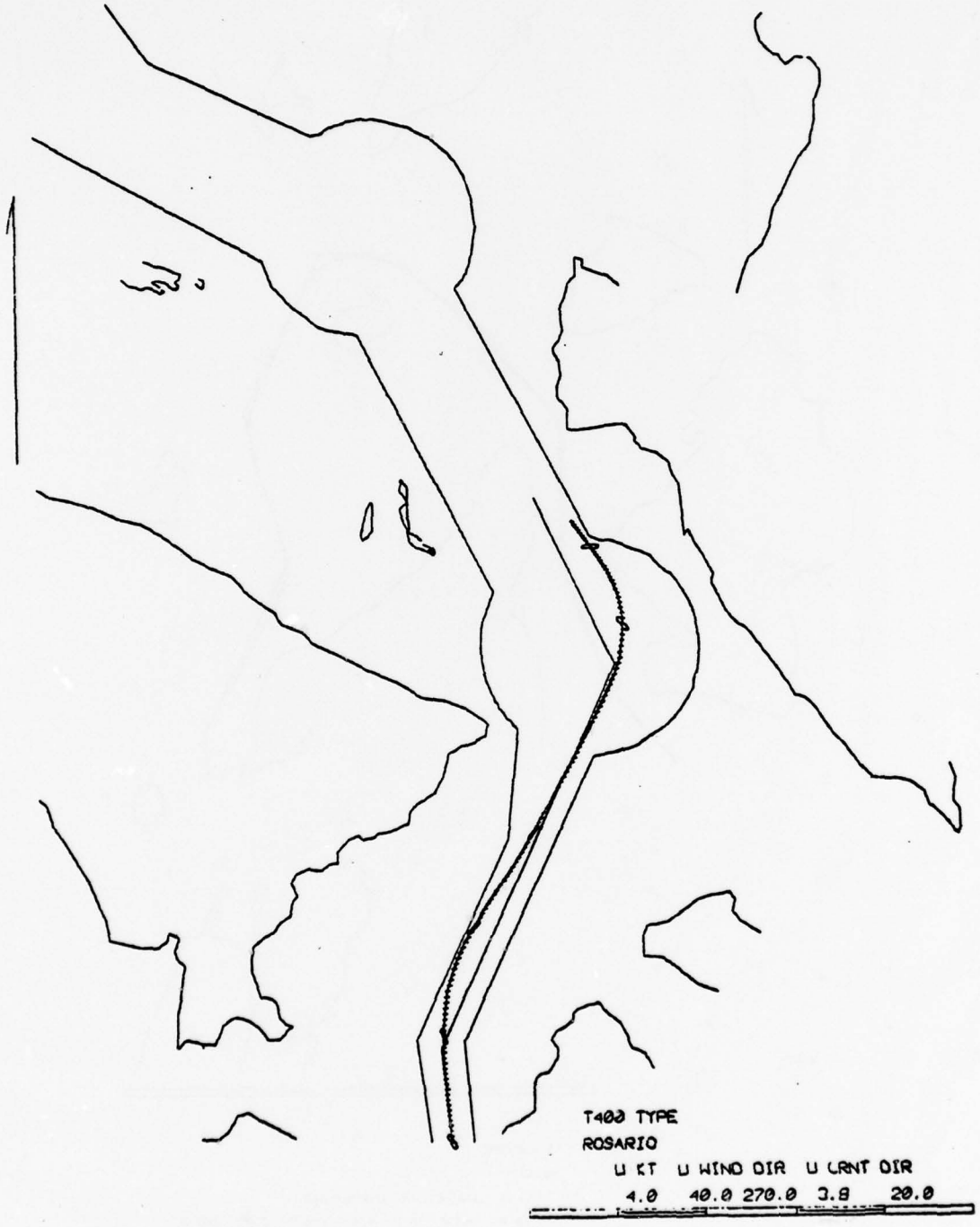

T400 TYPE
ROSARIO
U KT U WIND DIR U CRNT DIR
8.0 40.0 270.0 3.8 20.0


T400 TYPE
ROSARIO
U KT U WIND DIR U CRNT DIR
8.0 40.0 90.0 3.8 20.0

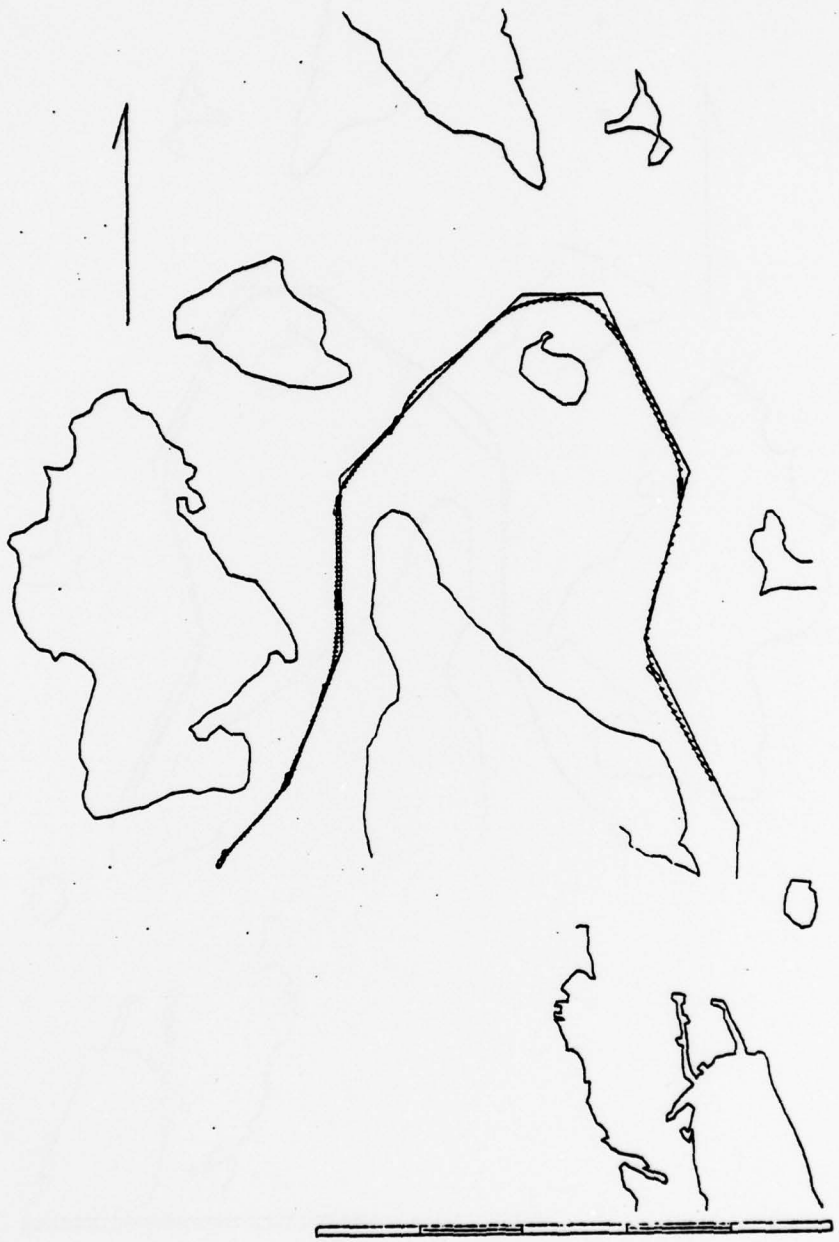

1400 TYPE
ROSARIO
U KT U WIND DIR U CRNT DIR
6.0 40.0 270.0 3.8 20.0


T400 TYPE
ROSARIO
U KT U WIND DIR U CRNT DIR
6.0 40.0 90.0 3.8 20.0


T400 TYPE
ROSARIO
U KT U WIND DIR U CRNT DIR
4.0 40.0 90.0 3.8 20.0


T400 TYPE
ROSARIO
U KT U WIND DIR U CRNT DIR
4.0 40.0 270.0 3.8 20.0

T 280TYPE
BELLHM
U KT U WIND DIR U CRNT DIR
10.0 40.0 90.0 4.5 190.0 2.0 240.0

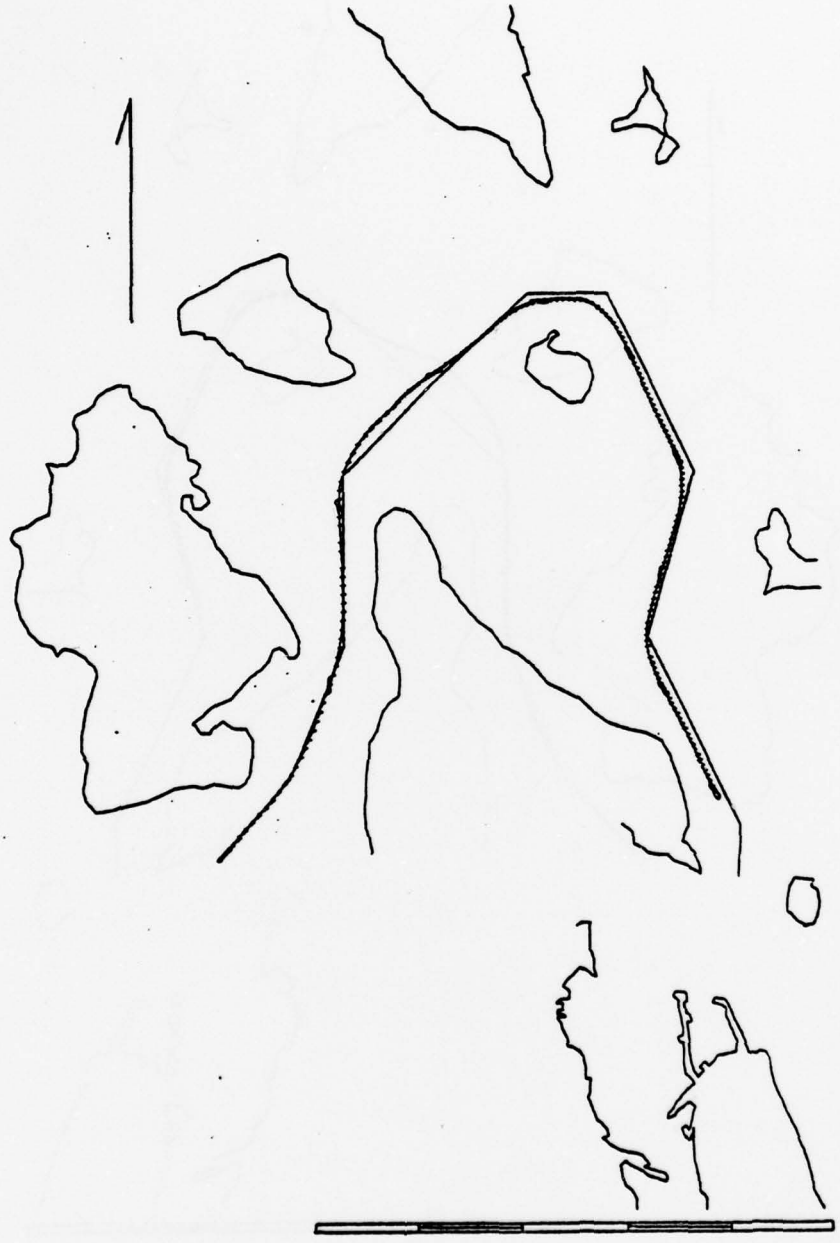


T400 TYPE

BELIM

U JET	U WIND DIR	U CONT DIR				
10.0	40.0	90.0	4.5	190.0	2.0	240.0

F 290TYPE
PELLYM
U CI U WIND DIR U CONT DIR
8.0 40.0 270.0 4.0 45.0 1 5 310.0



T 280TYPE

PEL'H

U-ET U WIND DIR U CONT DIR

6.0 40.0 270.0 4.0 45.0 1.5 310.0

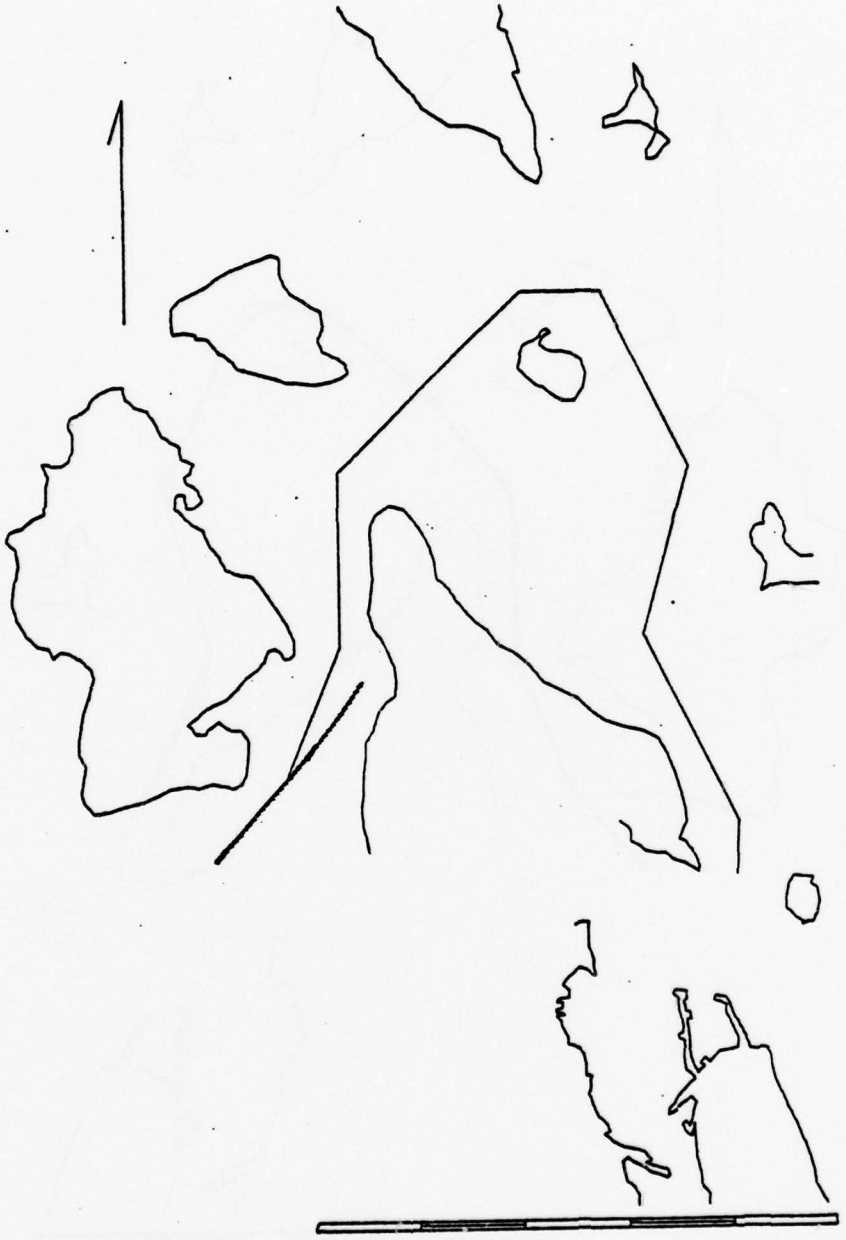
T 290T:PS

RELU-M

U CT U WIND DIR U CONT DIR

6.0 40.0 90.0 4.0 45.0 1.5 210.0

T 280TYPE
BELLHM
U KT U WIND DIR U CRNT DIR
4.0 40.0 270.0 4.0 45.0 1.5 310.0



T 280TYPE
BELLMH
U ET U WIND DIR U CRNT DIR
4.0 40.0 90.0 4.0 45.0 1.5 210.0

T488 TYPE

BELNM

U ET	U WIND DIR	U CRNT DIR
10.0	40.0 270.0 4.5	180.0 2.0 240.0

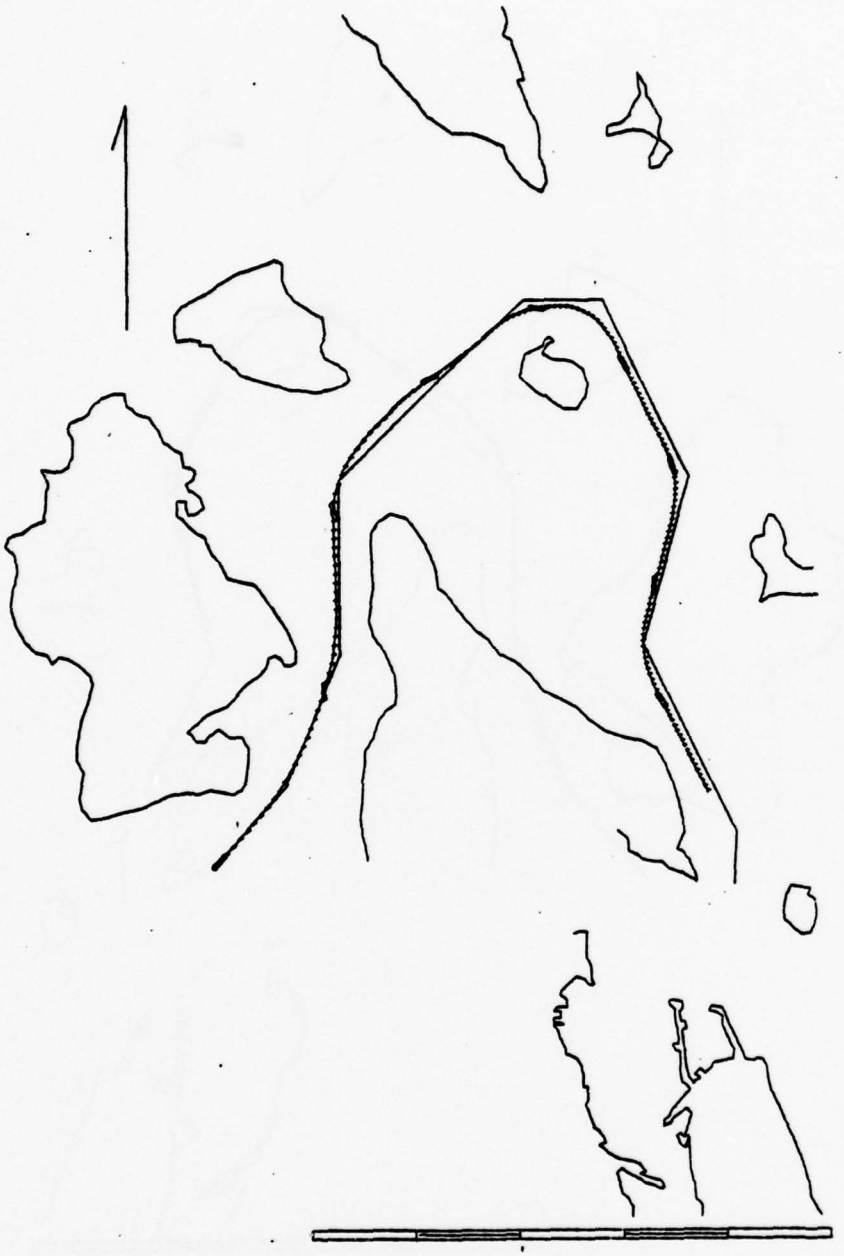
T=00 TYPE
BELMY
U KT U WIND DIR U CRNT DIR
10.0 40.0 90.0 4.5 180.0 2.0 240.0

T400 TYPE

BELHM

U KT U WIND DIR U CRNT DIR

8.0 40.0 270.0 4.0 46.0 1.5 310.0



T408 TYPE

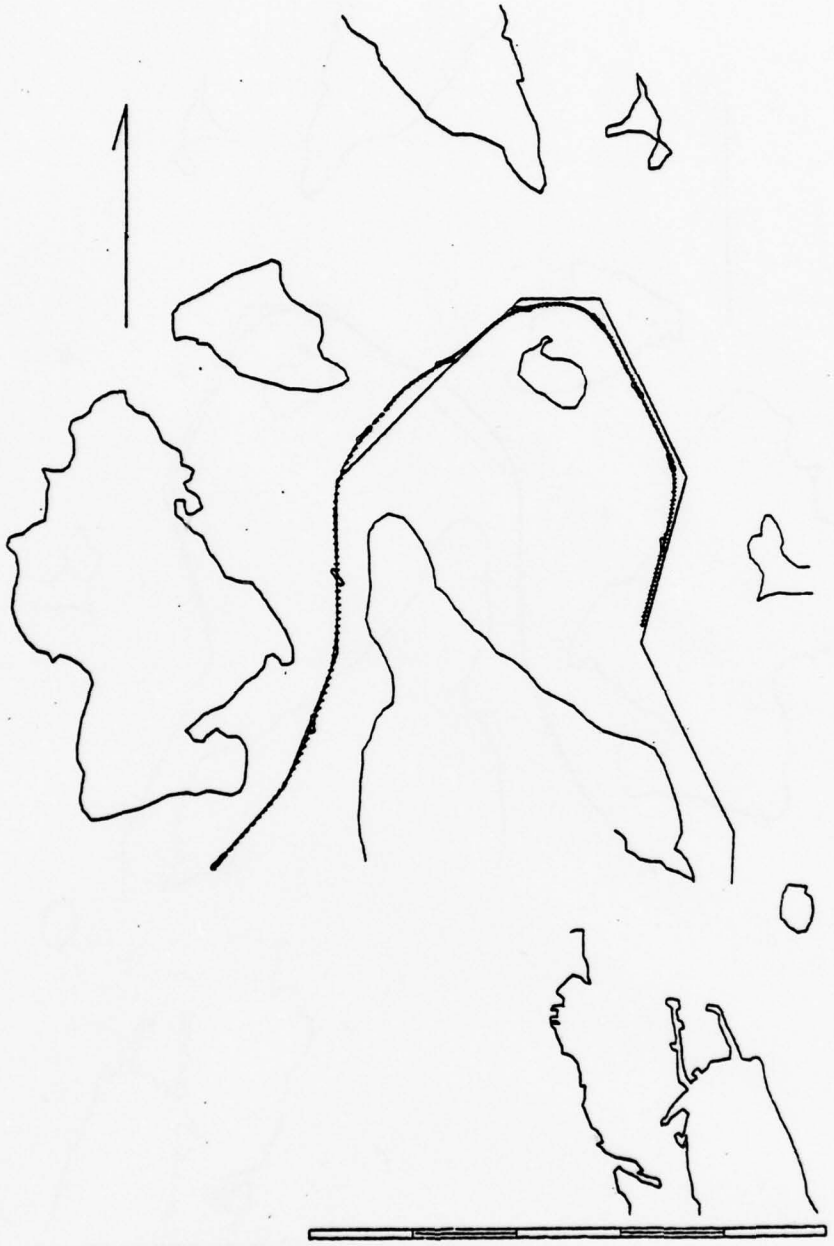
SELMM

U EF	U WIND DIR	U CONT DIR			
0.0	40.0	90.0	4.0	45.0	1.5	210.0

T-400 TYPE

BELHM

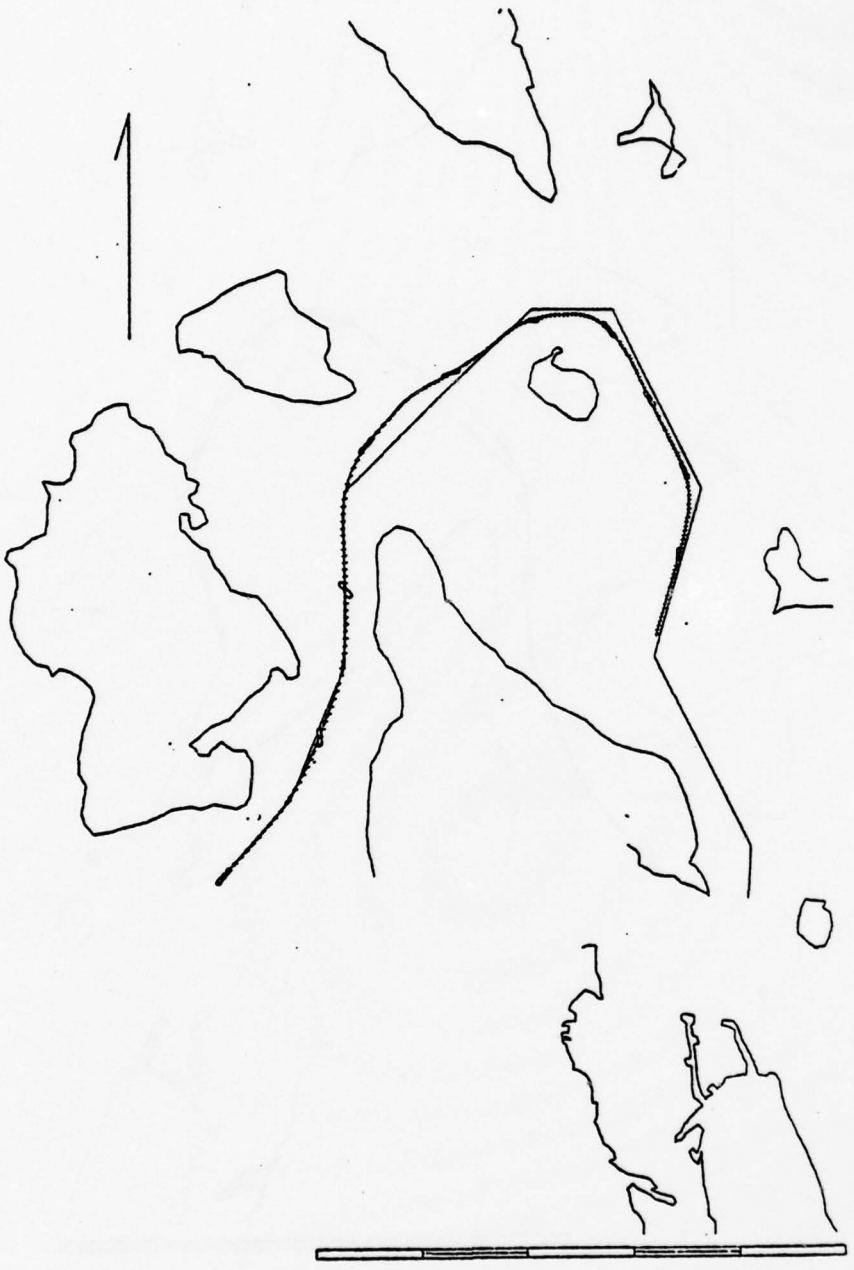
U ET	U WIND DIR	U CONT DIP			
6.0	40.0 270.0	4.0	45.0	1.5	210.0



T400 TYPE

BEIJ41

U ET	U WIND	DIR	U CRNT	DIR		
6.0	40.0	90.0	4.0	45.0	1.5	210.0



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T400 TYPE
BELIN1
   U ET   U WIND DIR   U CONT DIP
    6.0   10.0 270.0   1.0   45.0  1.5   210.0
```

T408 TYPE

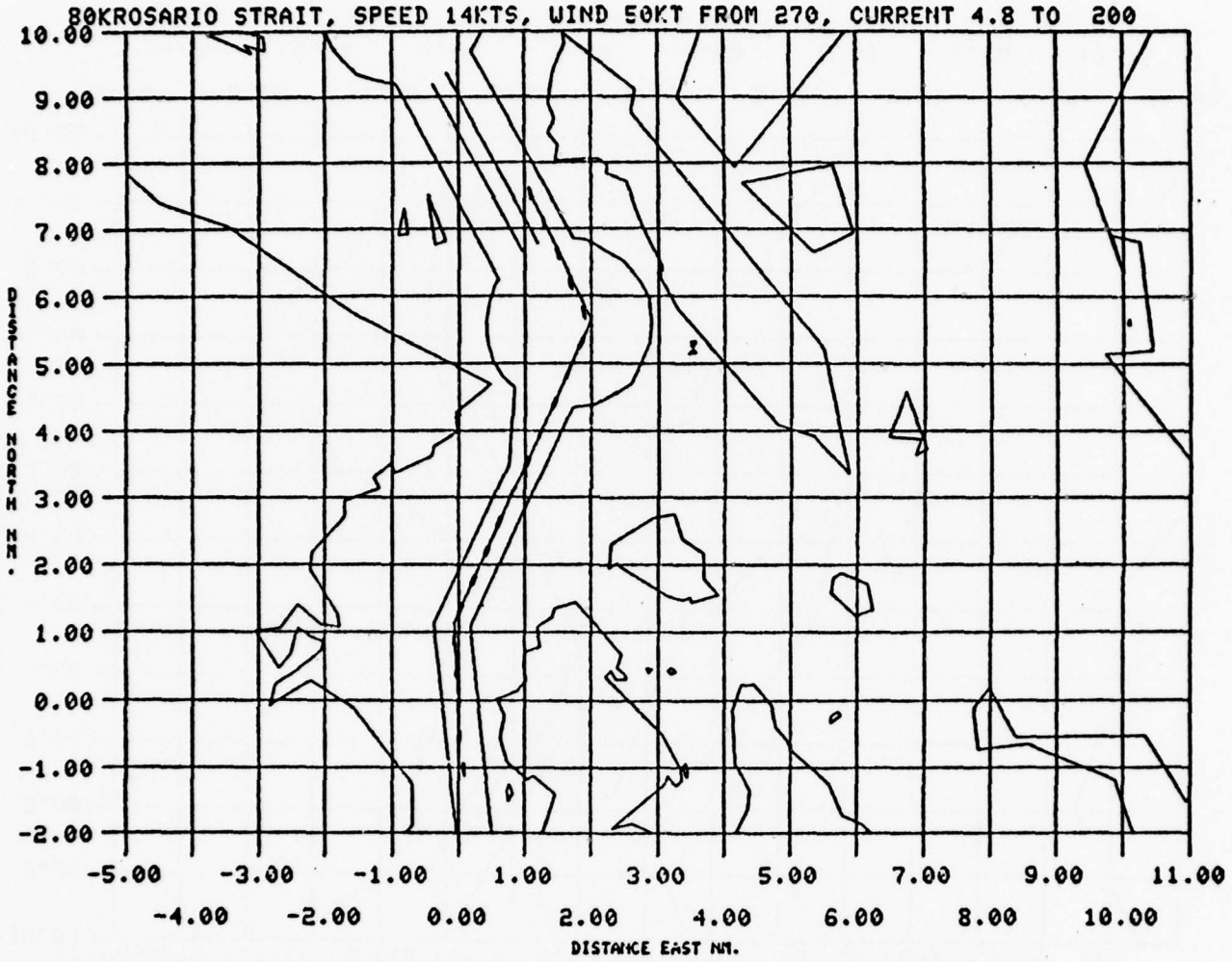
BELHM

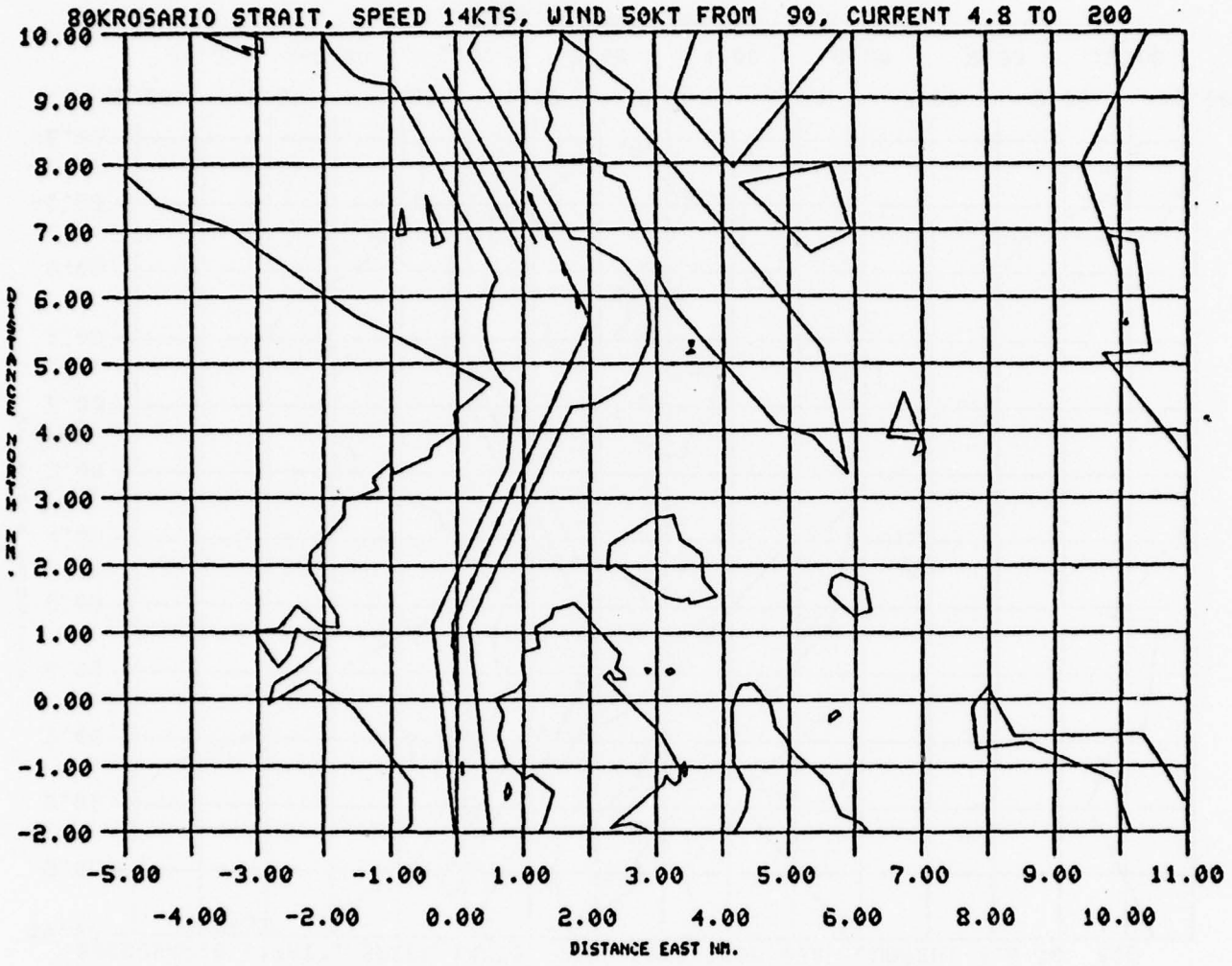
U ET	U WIND DIR	U CRNT DIR			
4.0	40.0	270.0	4.0	45.0	1.5	210.0

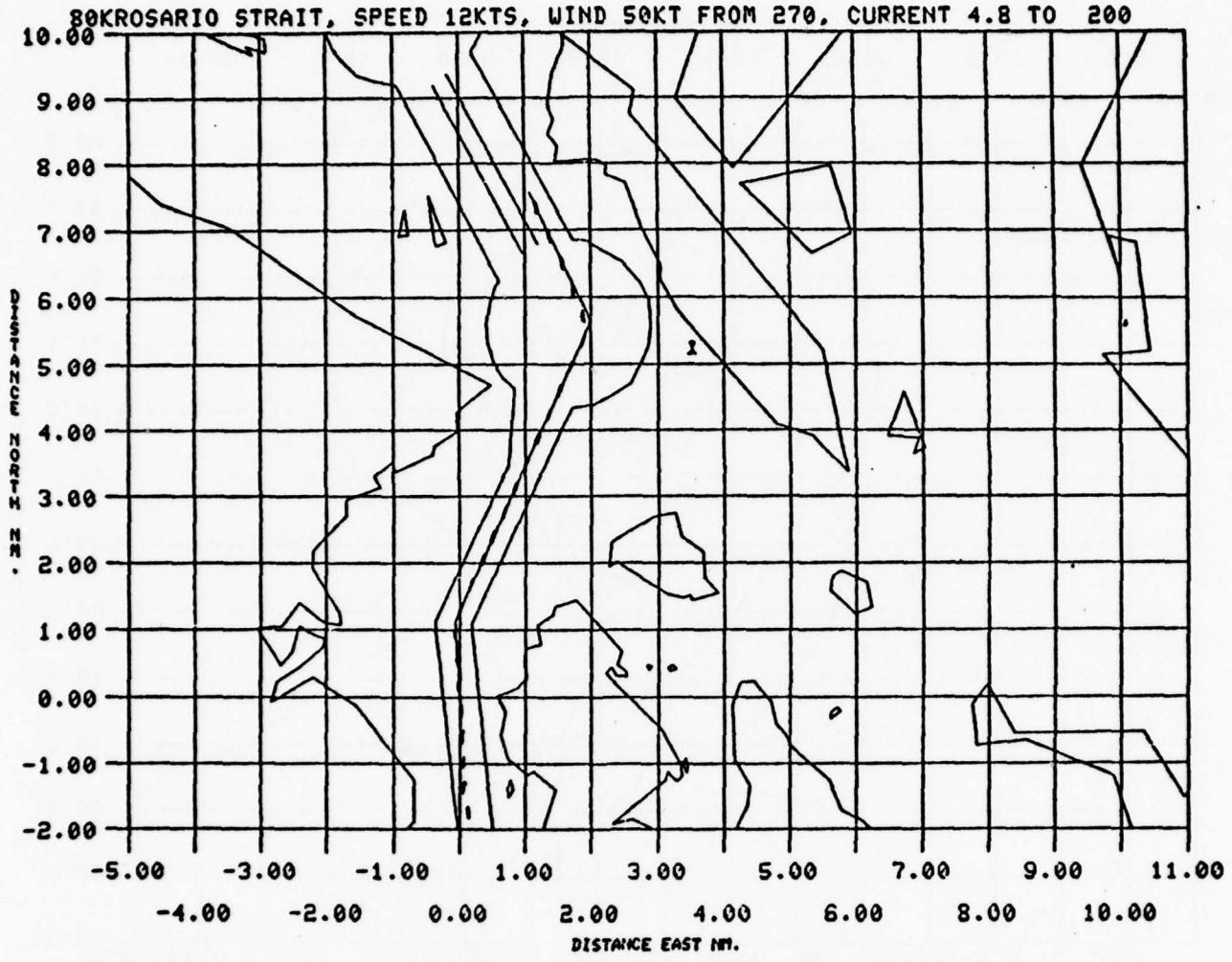
T400 TYPE

BELHV

U EF	U WIND DIR	U CENT DIR				
4.0	40.0	90.0	4.0	45.0	1.5	210.0


BØKROSARIO STRAIT, SPEED 14KTS, WIND 50KT FROM 270, CURRENT 4.8 TO 200
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
DISTANCE NORTH NM.
-5.00
-3.00
-1.00
1.00
3.00
5.00
7.00
9.00
11.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
DISTANCE EAST NM.


80KROSARIO STRAIT, SPEED 14KTS, WIND 50KT FROM 90, CURRENT 4.8 TO 200
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
DISTANCE NORTH NM.
-5.00
-3.00
-1.00
1.00
3.00
5.00
7.00
9.00
11.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
DISTANCE EAST NM.


80KROSARIO STRAIT, SPEED 12KTS, WIND 50KT FROM 270, CURRENT 4.8 TO 200
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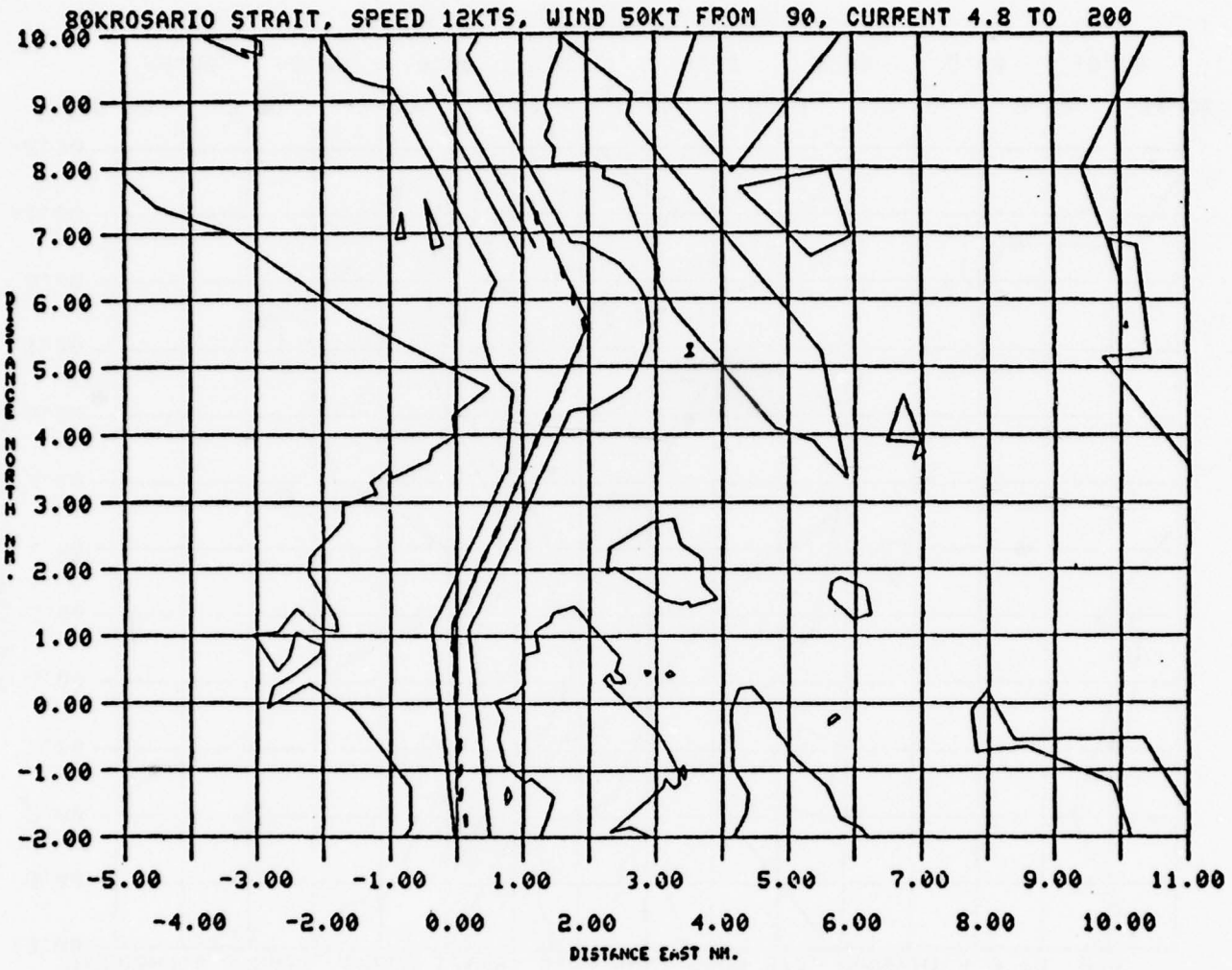
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
DISTANCE NORTH NM.
-5.00
-3.00
-1.00
1.00
3.00
5.00
7.00
9.00
11.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
DISTANCE EAST NM.


80KROSARIO STRAIT, SPEED 12KTS, WIND 50KT FROM 90, CURRENT 4.8 TO 200
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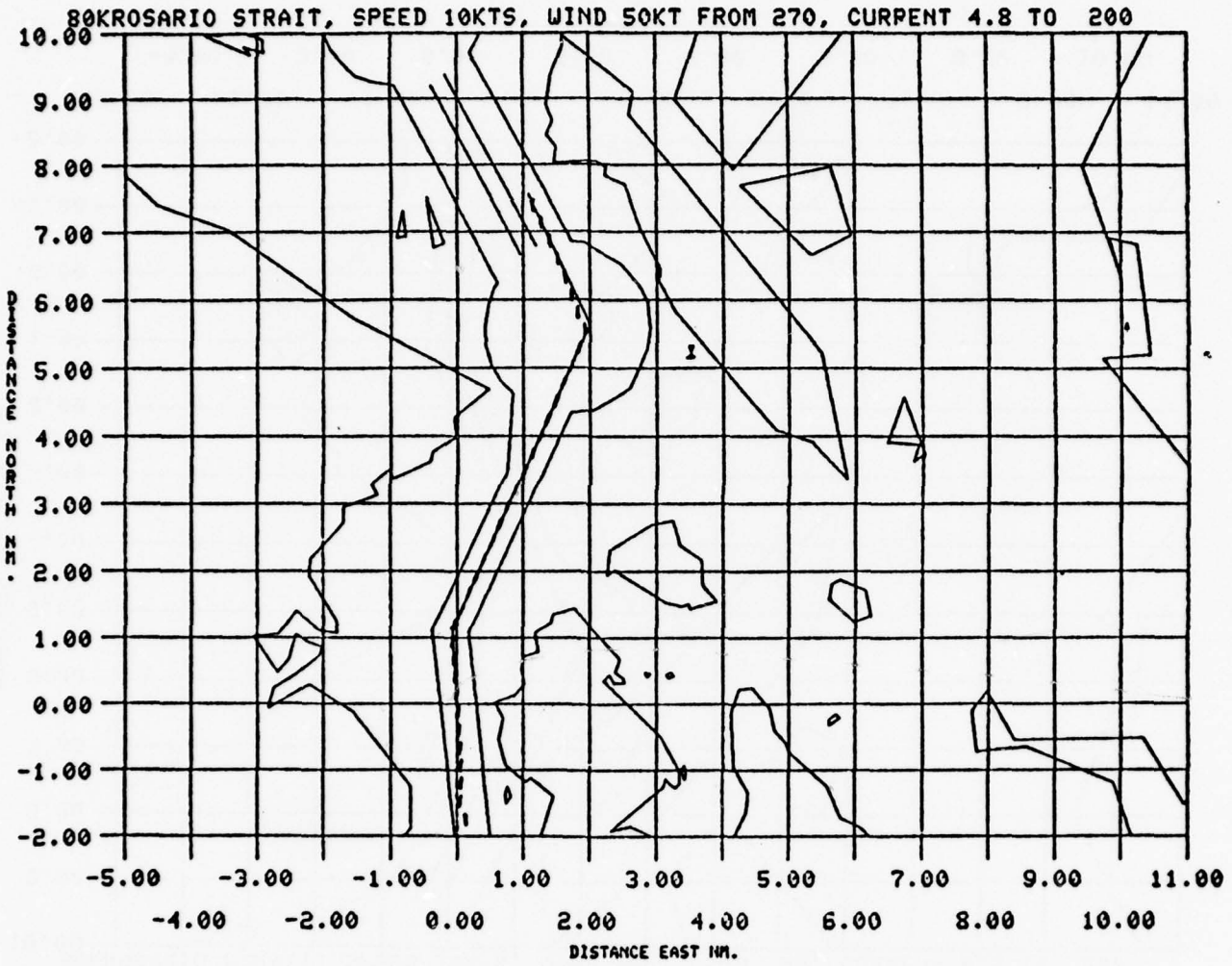
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
DISTANCE NORTH NM.
-5.00
-3.00
-1.00
1.00
3.00
5.00
7.00
9.00
11.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
DISTANCE EAST NM.


80KROSARIO STRAIT, SPEED 10KTS, WIND 50KT FROM 270, CURRENT 4.8 TO 200
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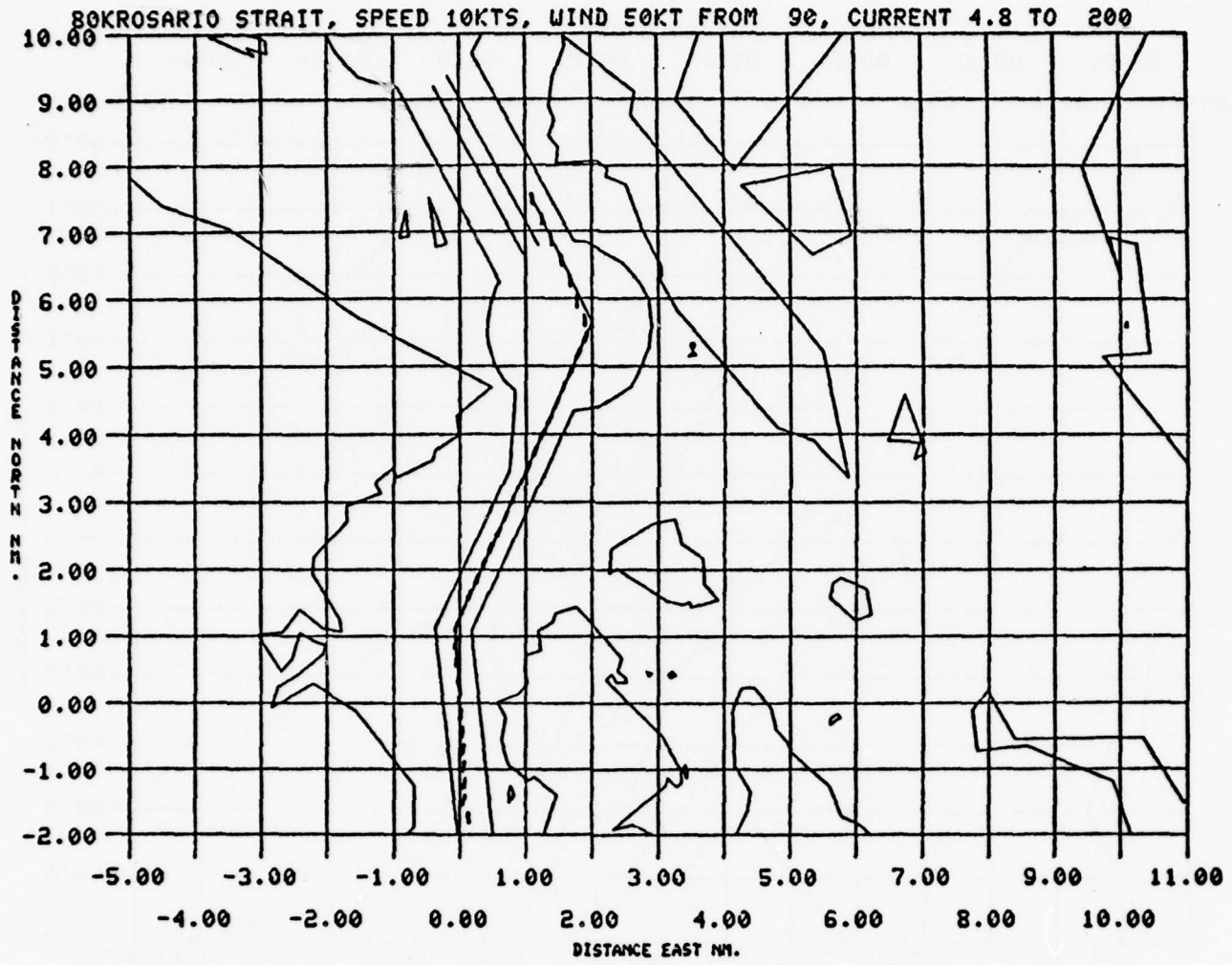
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
DISTANCE NORTH NM.
-5.00
-3.00
-1.00
1.00
3.00
5.00
7.00
9.00
11.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
DISTANCE EAST NM.


80KROSARIO STRAIT, SPEED 10KTS, WIND 50KT FROM 90, CURRENT 4.8 TO 200
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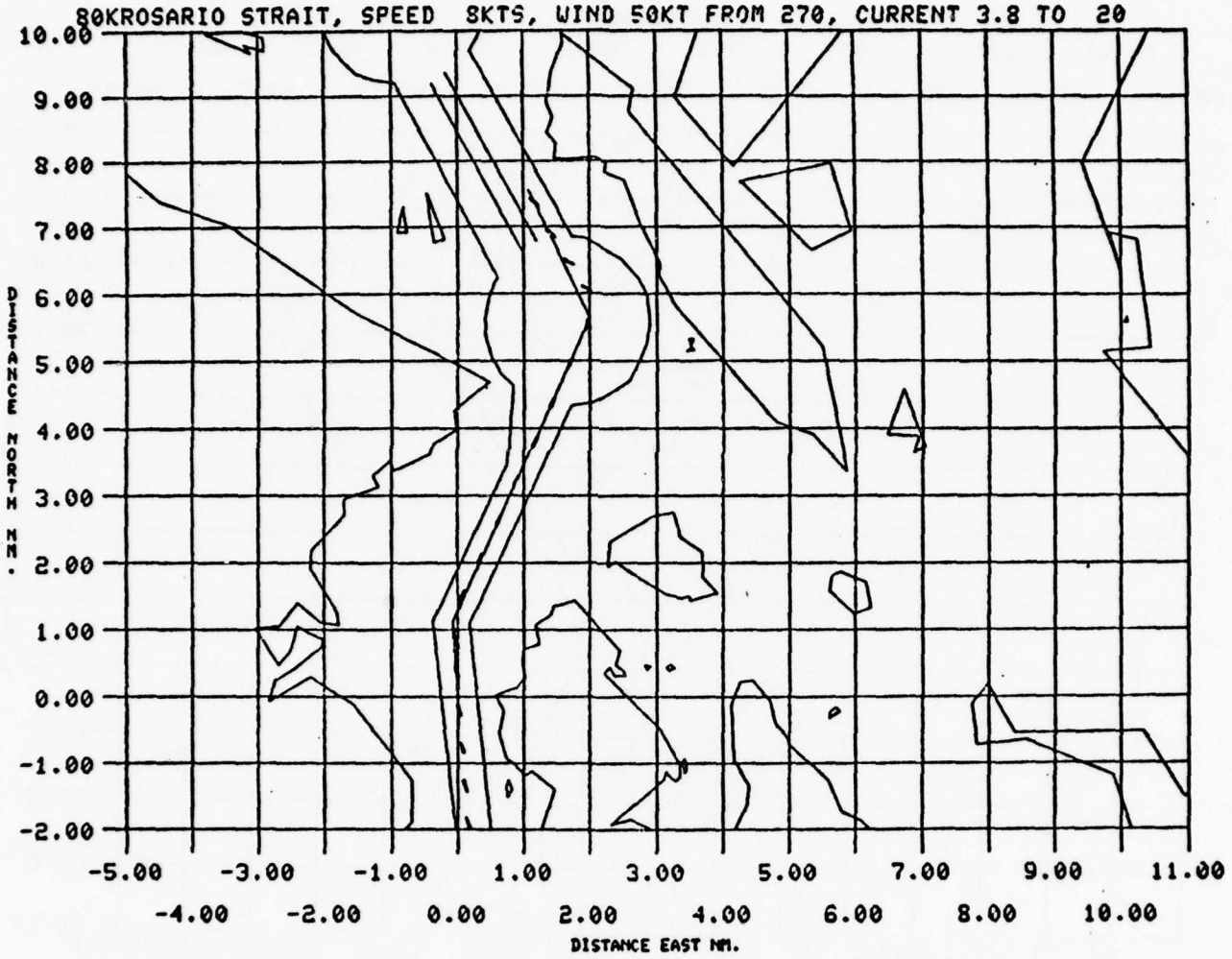
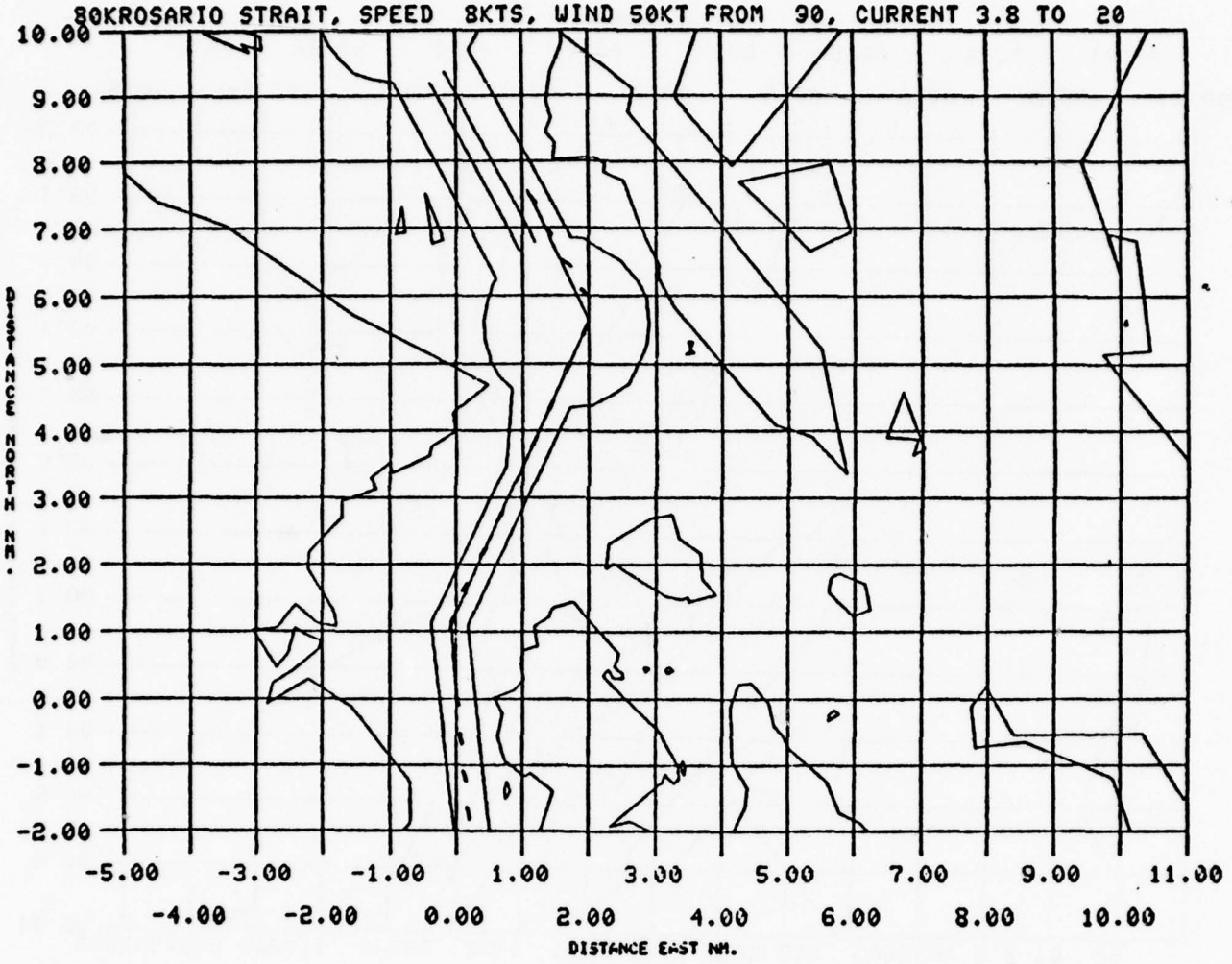
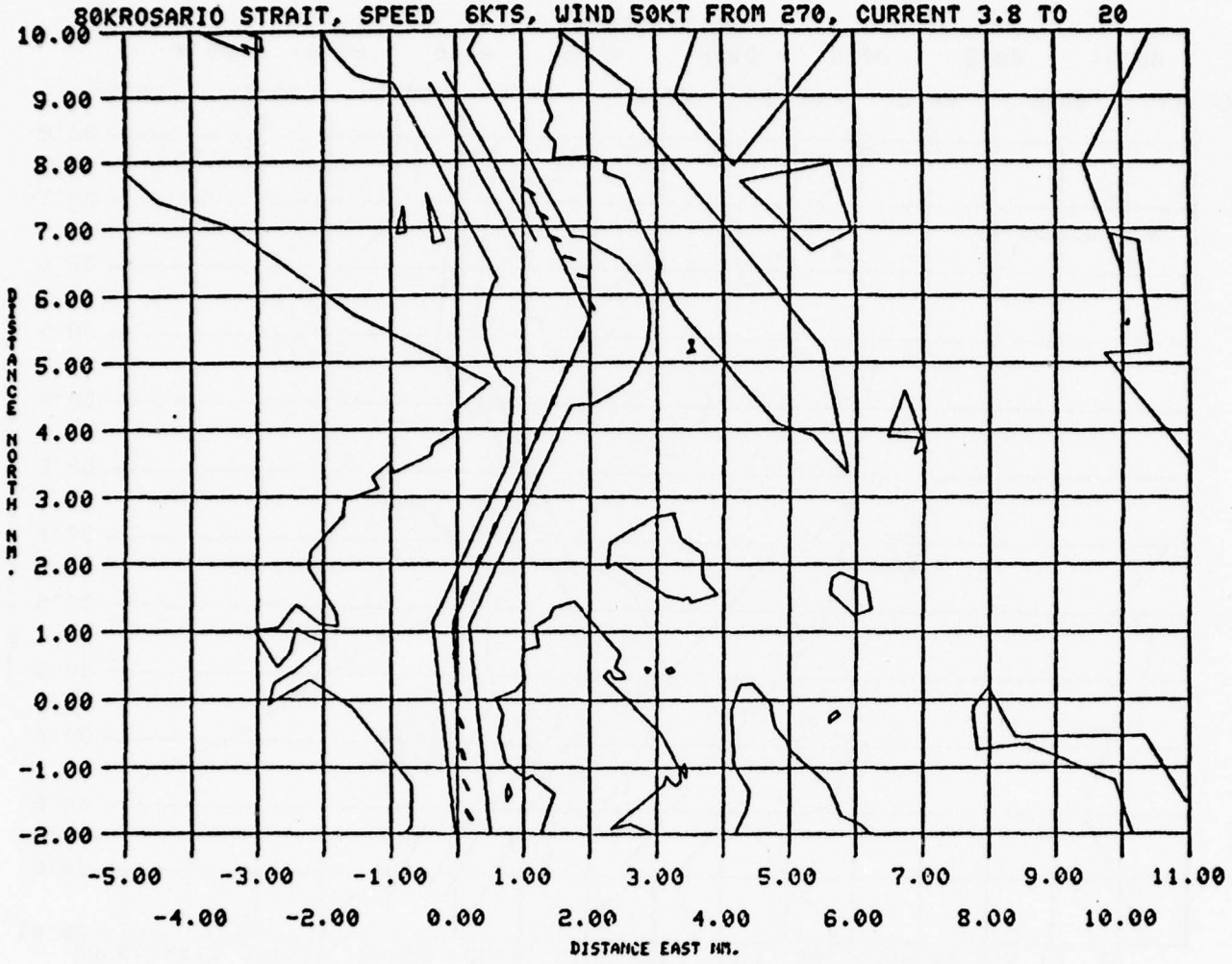
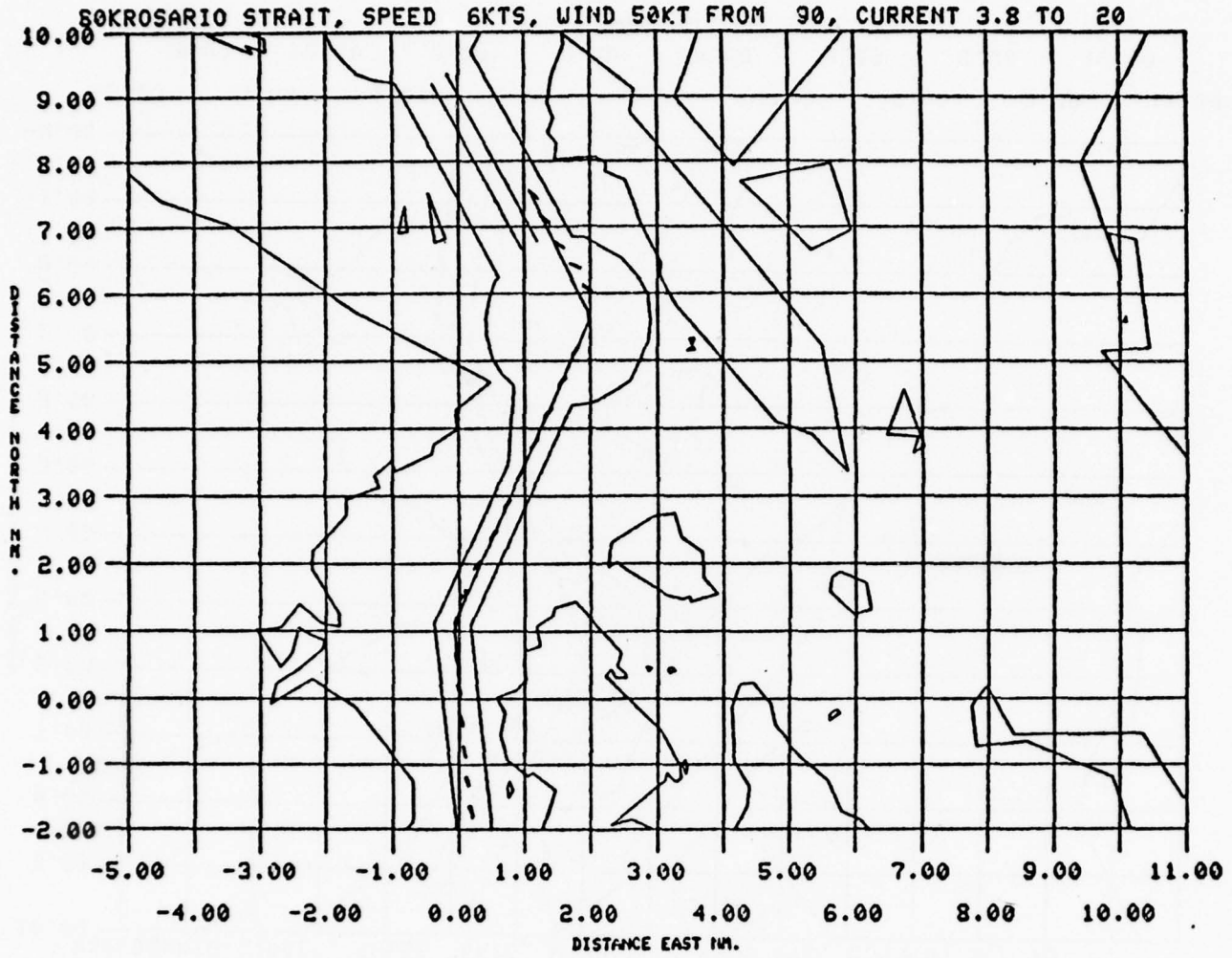
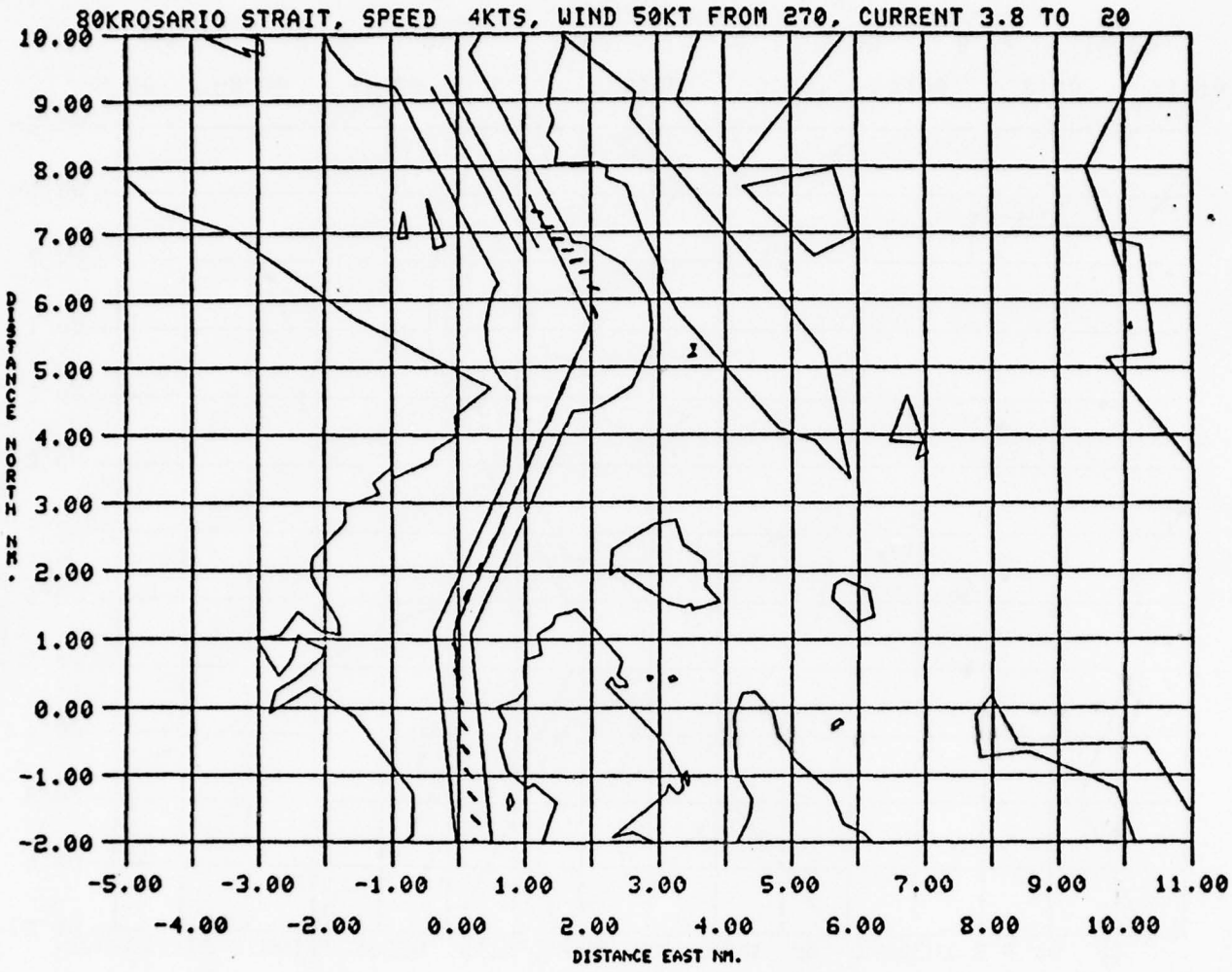
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
DISTANCE NORTH NM.
-5.00
-3.00
-1.00
1.00
3.00
5.00
7.00
9.00
11.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
DISTANCE EAST NM.


80KROSARIO STRAIT, SPEED 8KTS, WIND 50KT FROM 270, CURRENT 3.8 TO 20
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
DISTANCE NORTH NM.
-5.00
-3.00
-1.00
1.00
3.00
5.00
7.00
9.00
11.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
DISTANCE EAST NM.


80KROSARIO STRAIT, SPEED 8KTS, WIND 50KT FROM 90, CURRENT 3.8 TO 20
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
DISTANCE NORTH NM.
-5.00
-3.00
-1.00
1.00
3.00
5.00
7.00
9.00
11.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
DISTANCE EAST NM.


80KROSARIO STRAIT, SPEED 6KTS, WIND 50KT FROM 270, CURRENT 3.8 TO 20
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
DISTANCE NORTH NM.
-5.00
-3.00
-1.00
1.00
3.00
5.00
7.00
9.00
11.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
DISTANCE EAST NM.


SOKROSARIO STRAIT, SPEED 6KTS, WIND 50KT FROM 90, CURRENT 3.8 TO 20
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
DISTANCE NORTH NM.
-5.00
-3.00
-1.00
1.00
3.00
5.00
7.00
9.00
11.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
DISTANCE EAST NM.


80KROSARIO STRAIT, SPEED 4KTS, WIND 50KT FROM 270, CURRENT 3.8 TO 20
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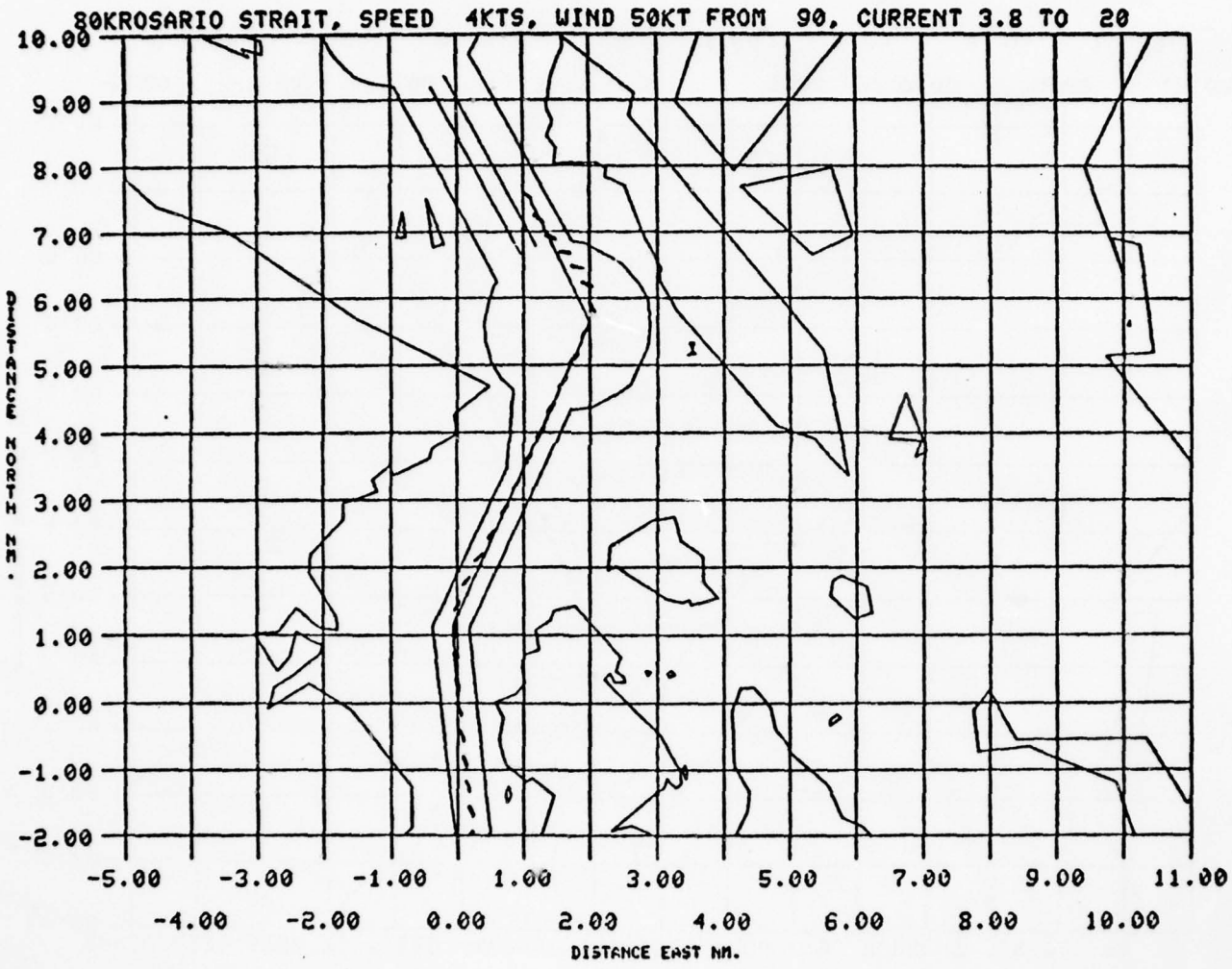
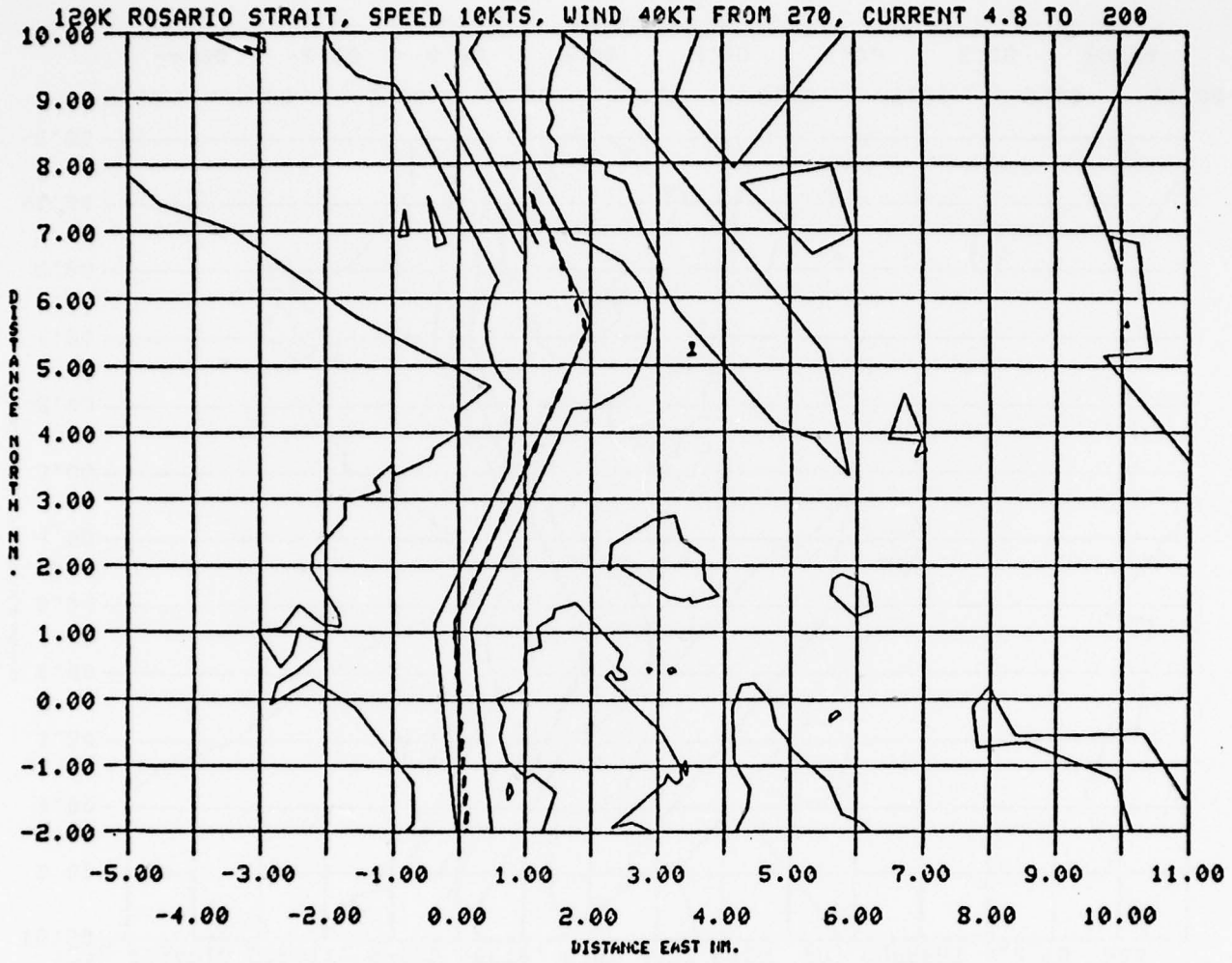
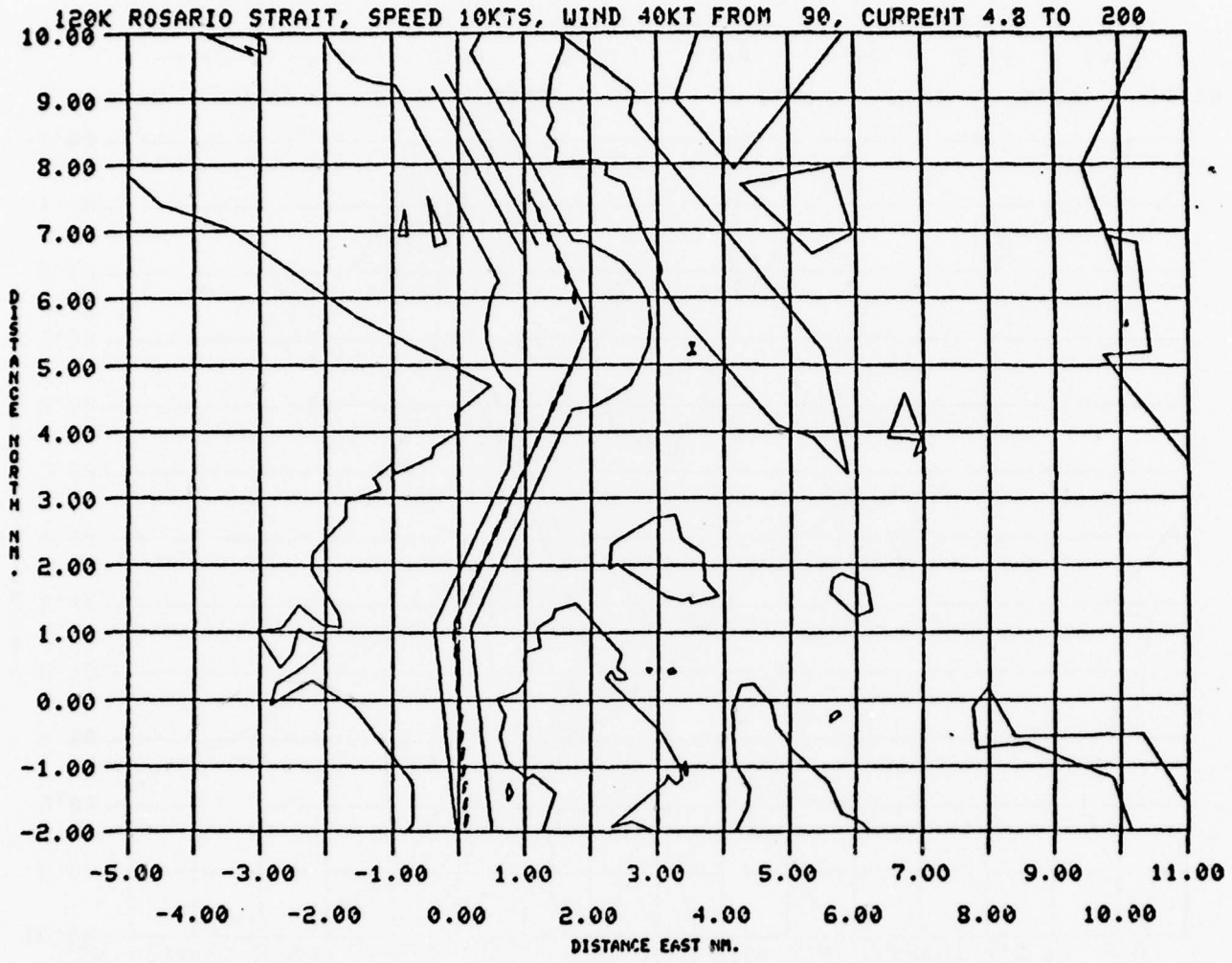
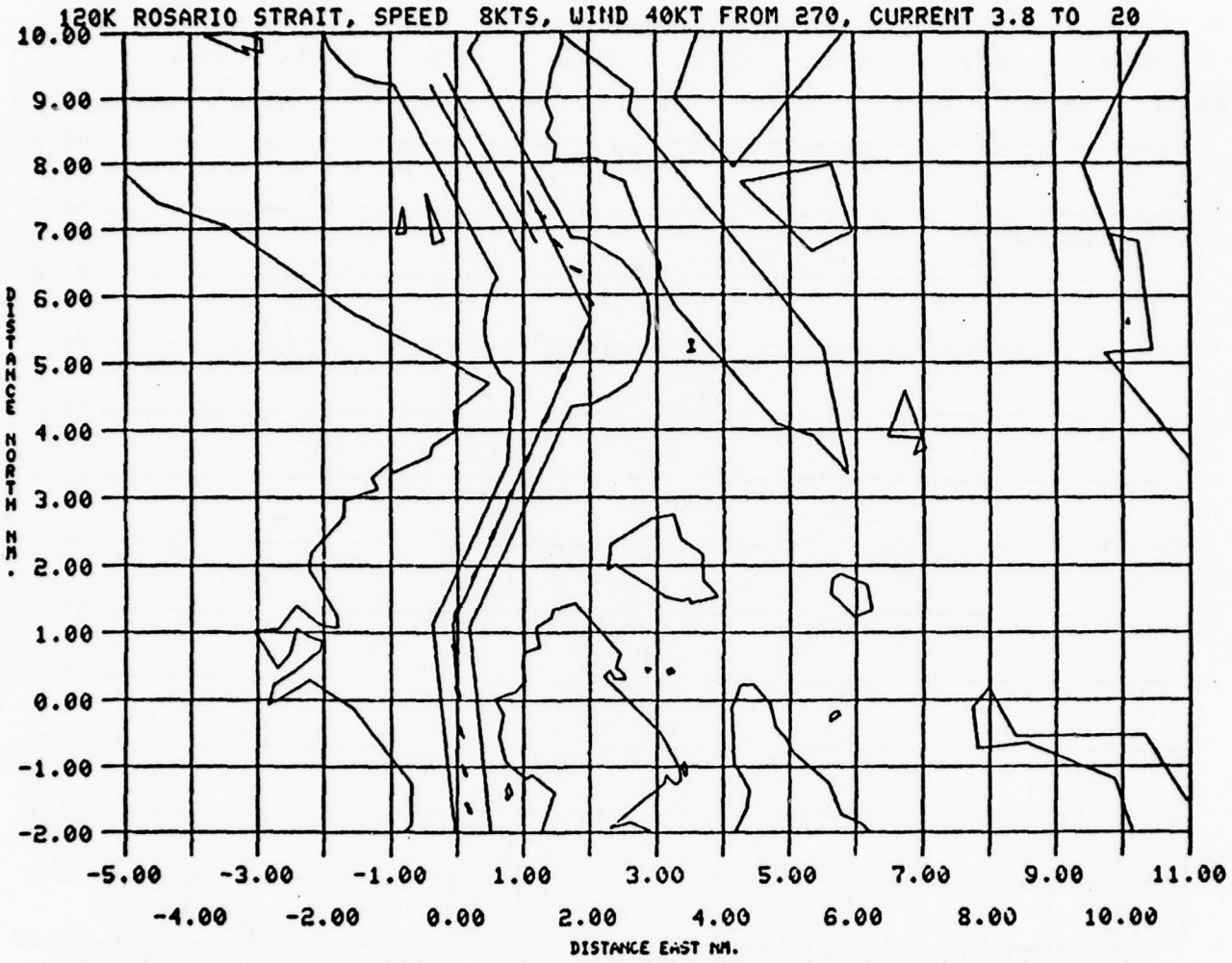
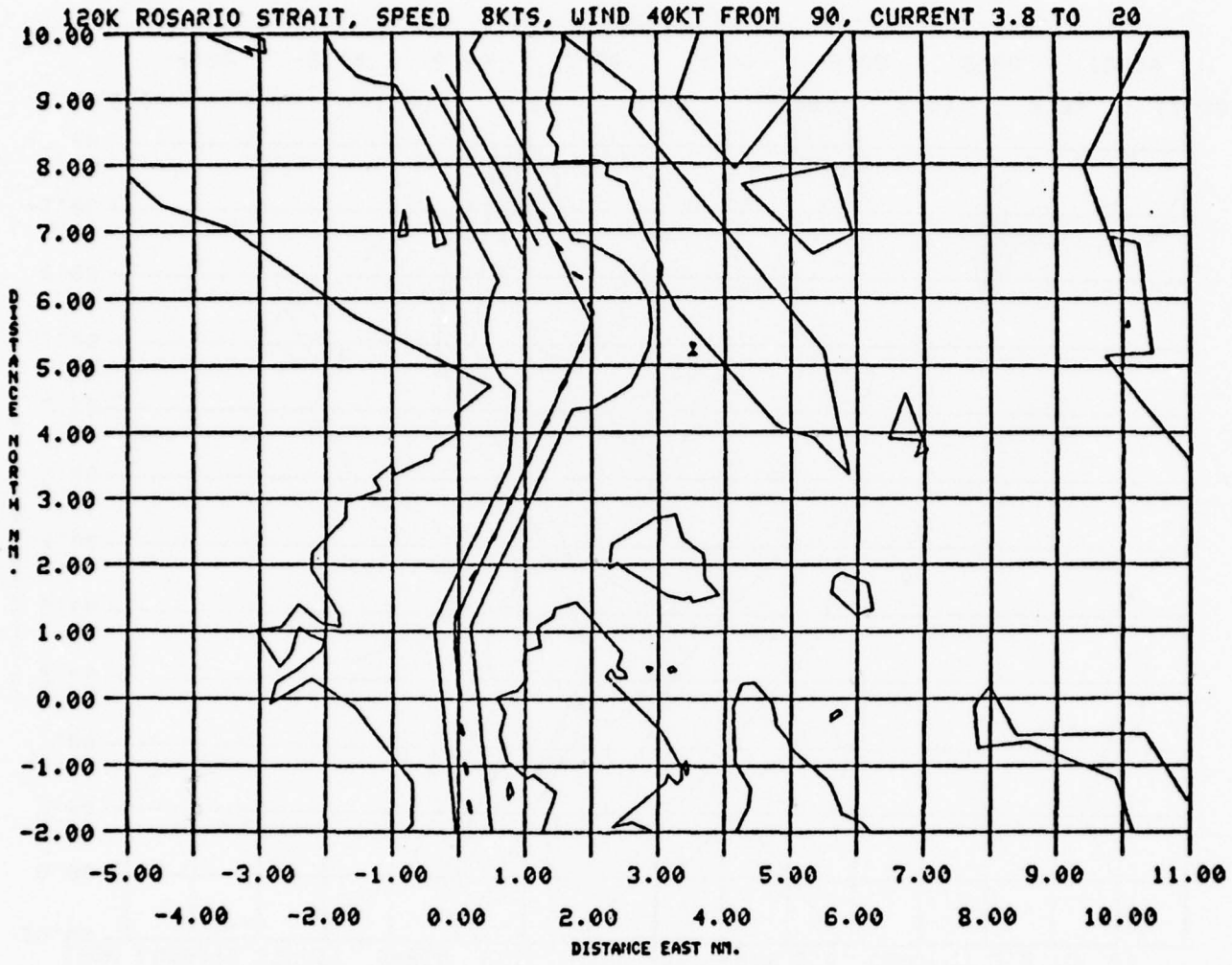
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
DISTANCE NORTH NM.
-5.00
-3.00
-1.00
1.00
3.00
5.00
7.00
9.00
11.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
DISTANCE EAST NM.

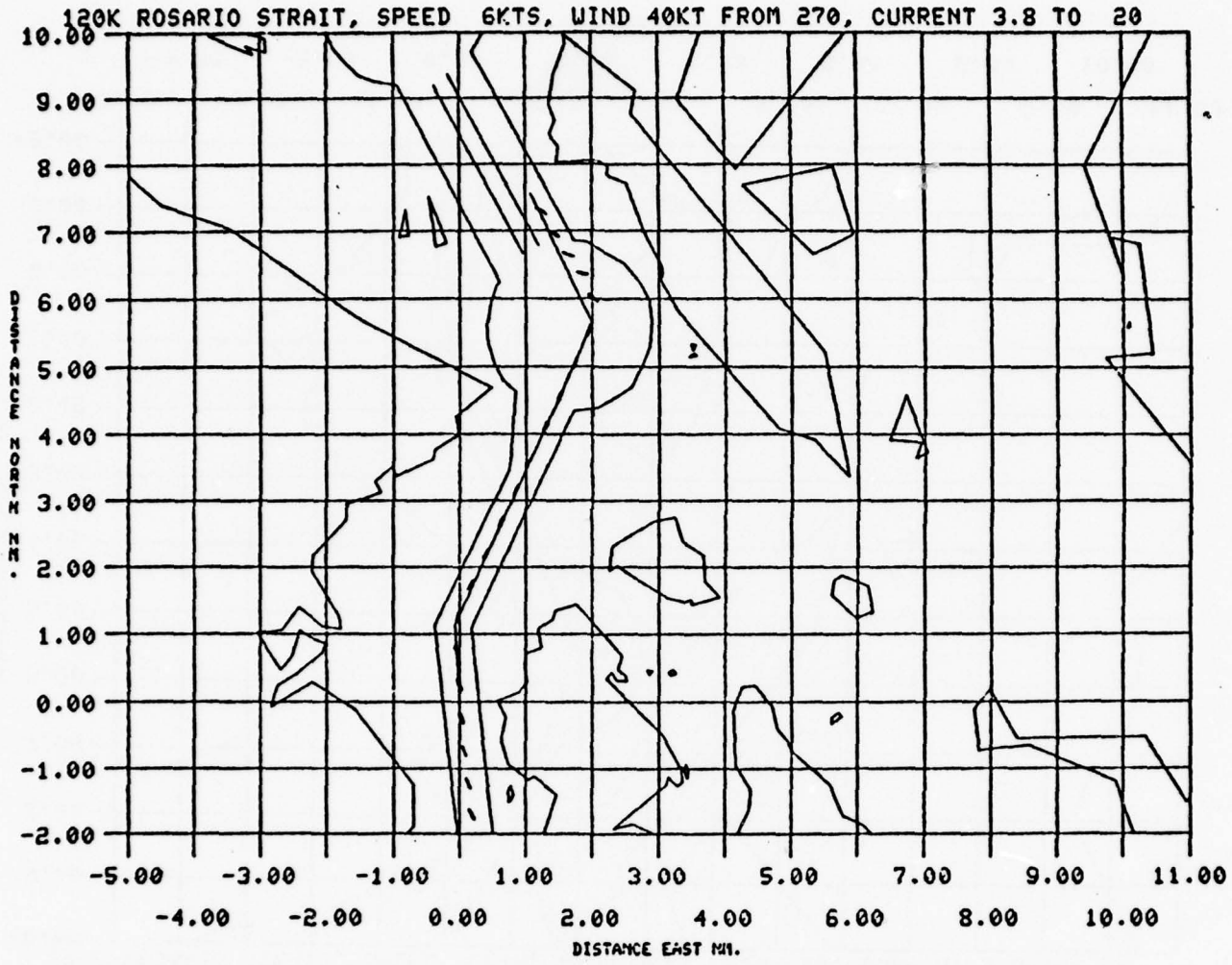

80KROSARIO STRAIT, SPEED 4KTS, WIND 50KT FROM 90, CURRENT 3.8 TO 20
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
DISTANCE NORTH NM.
-5.00
-3.00
-1.00
1.00
3.00
5.00
7.00
9.00
11.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
DISTANCE EAST NM.

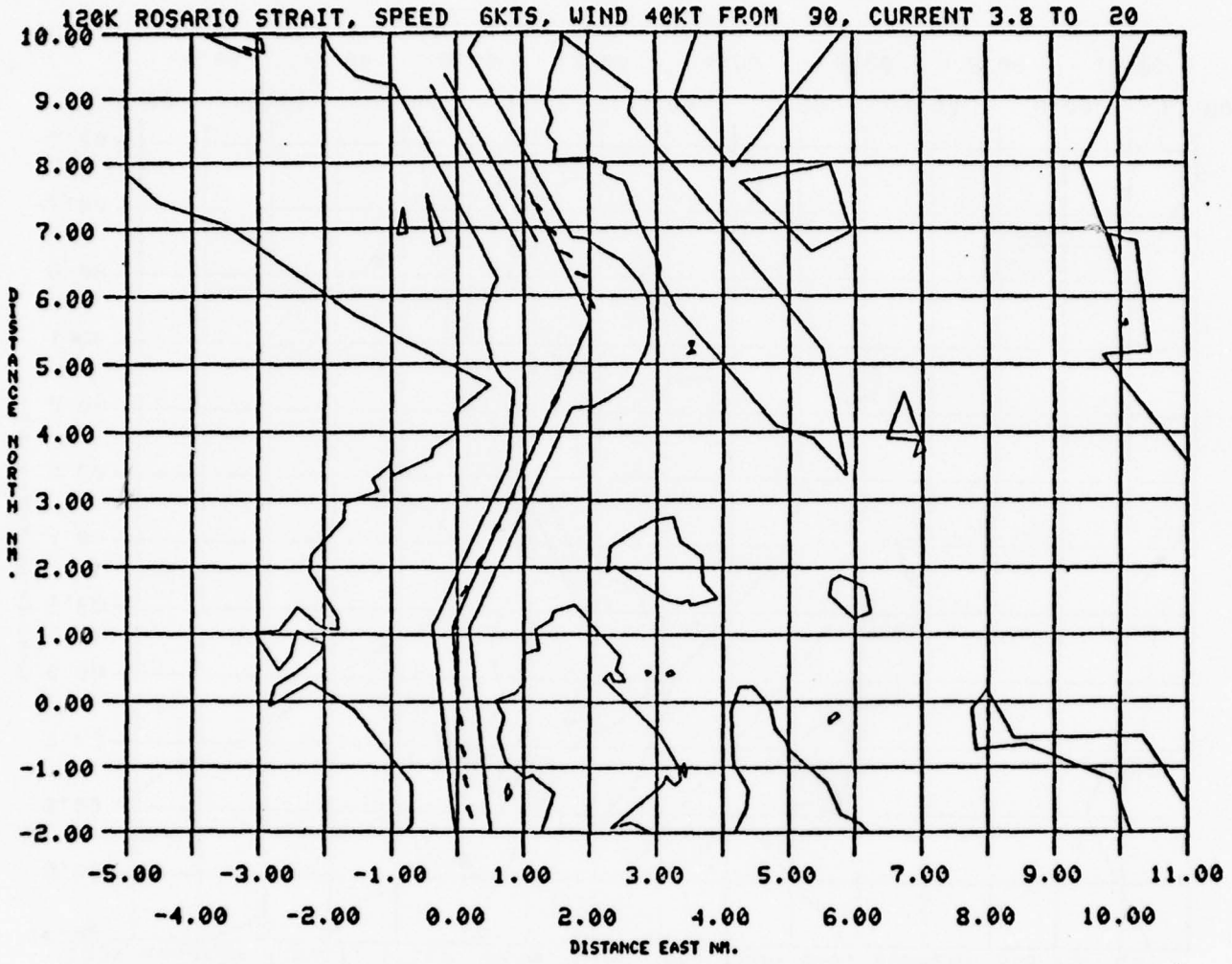

120K ROSARIO STRAIT, SPEED 10KTS, WIND 40KT FROM 270, CURRENT 4.8 TO 200
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
DISTANCE NORTH NM.
-5.00
-3.00
-1.00
1.00
3.00
5.00
7.00
9.00
11.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
DISTANCE EAST NM.

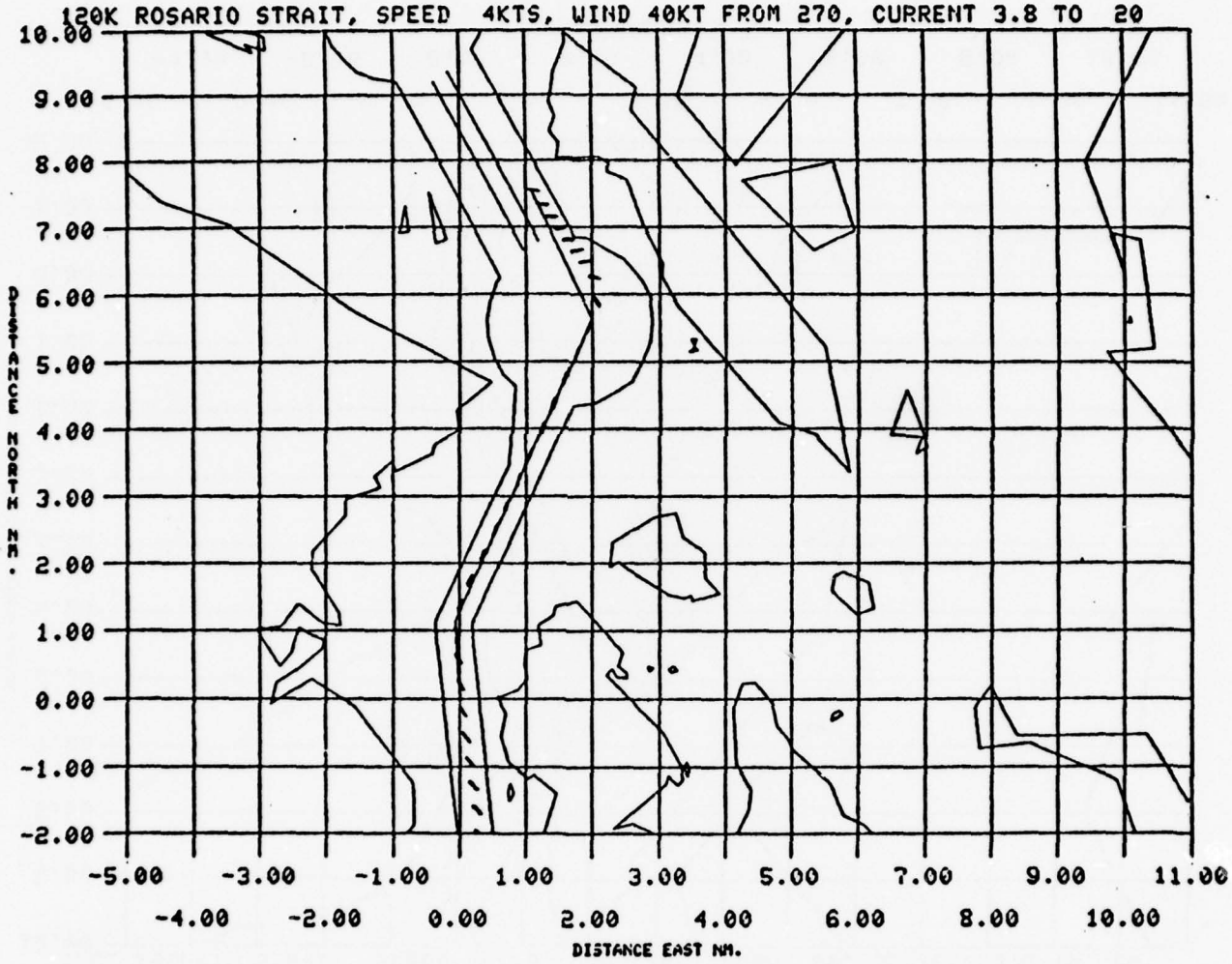

120K ROSARIO STRAIT, SPEED 10KTS, WIND 40KT FROM 90, CURRENT 4.8 TO 200
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
DISTANCE NORTH NM.
-5.00
-3.00
-1.00
1.00
3.00
5.00
7.00
9.00
11.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
DISTANCE EAST NM.

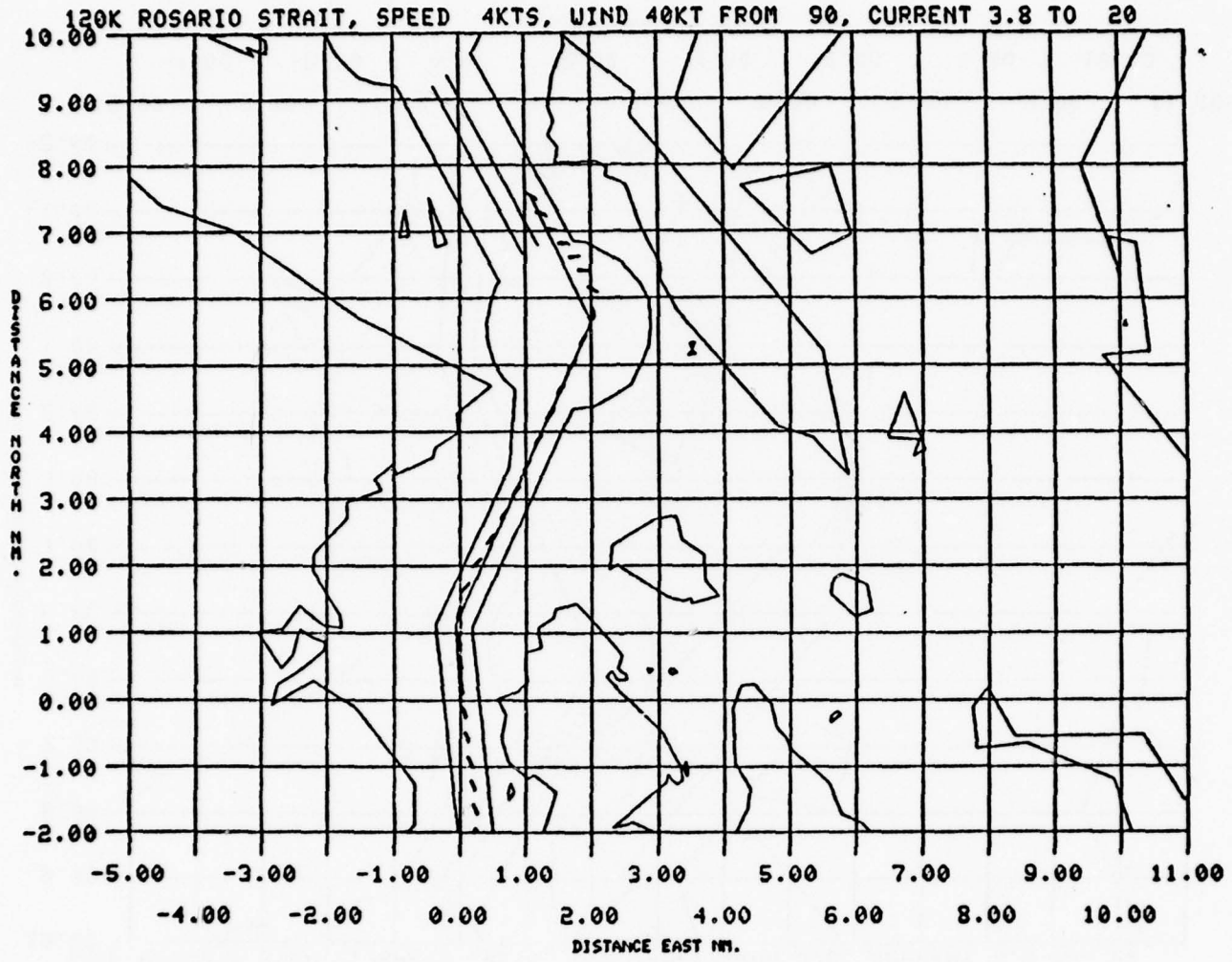

120K ROSARIO STRAIT, SPEED 8KTS, WIND 40KT FROM 270, CURRENT 3.8 TO 20
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
DISTANCE NORTH NM.
-5.00
-3.00
-1.00
1.00
3.00
5.00
7.00
9.00
11.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
DISTANCE EAST NM.

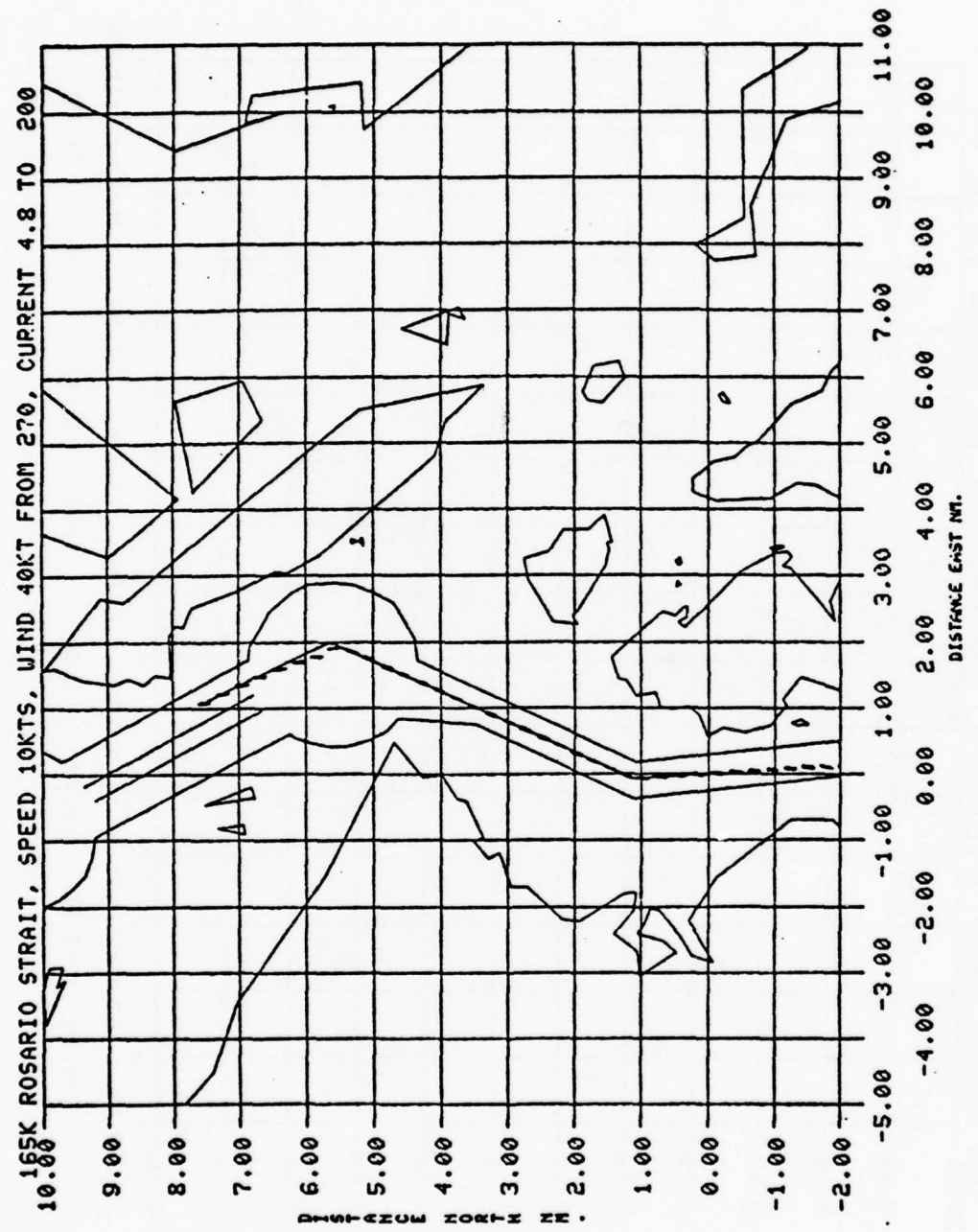

120K ROSARIO STRAIT, SPEED 8KTS, WIND 40KT FROM 90, CURRENT 3.8 TO 20
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
DISTANCE NORTH NM.
-5.00
-3.00
-1.00
1.00
3.00
5.00
7.00
9.00
11.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
DISTANCE EAST NM.

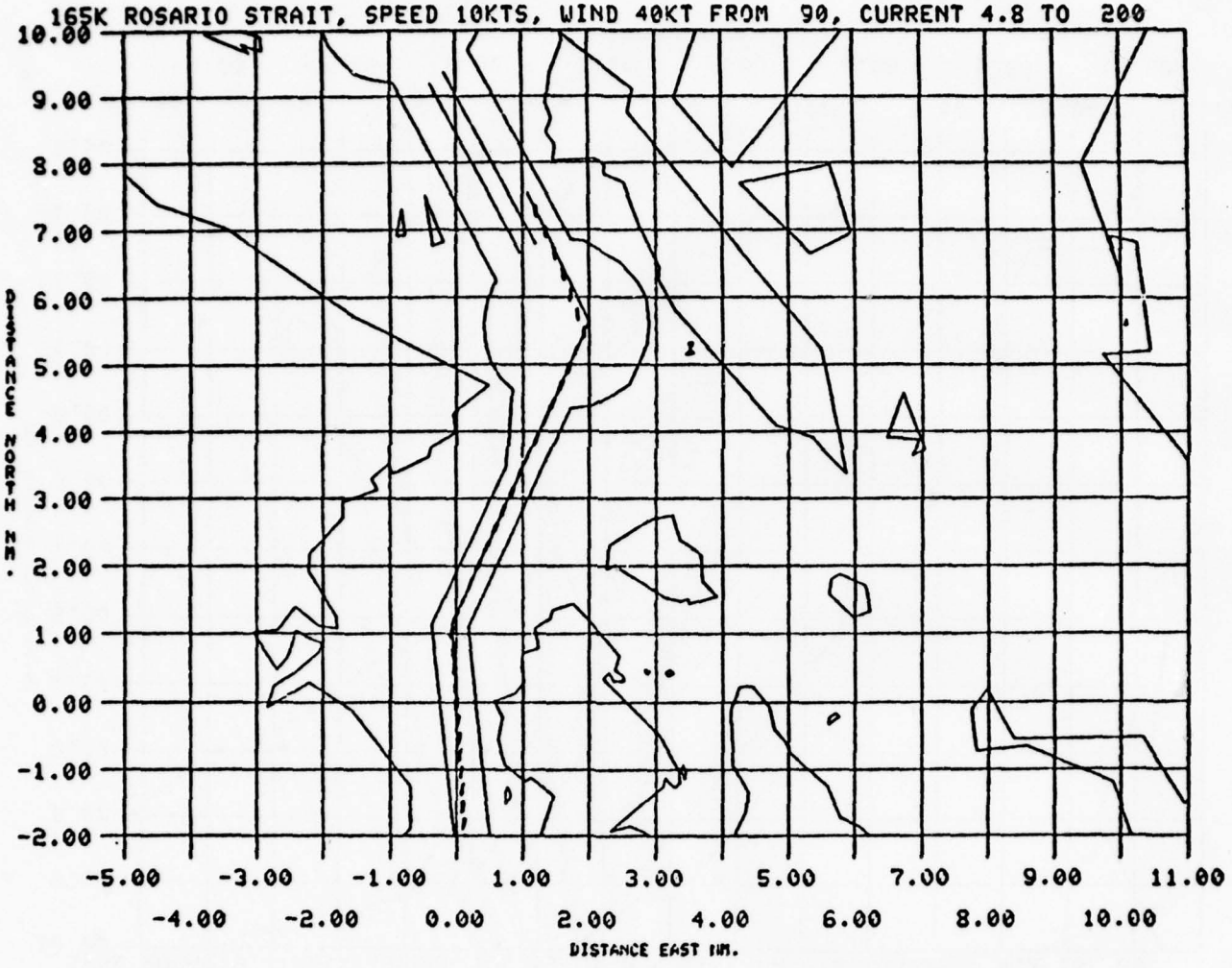

120K ROSARIO STRAIT, SPEED 6KTS, WIND 40KT FROM 270, CURRENT 3.8 TO 20
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
DISTANCE NORTH NM.
-5.00
-3.00
-1.00
1.00
3.00
5.00
7.00
9.00
11.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
DISTANCE EAST NM.

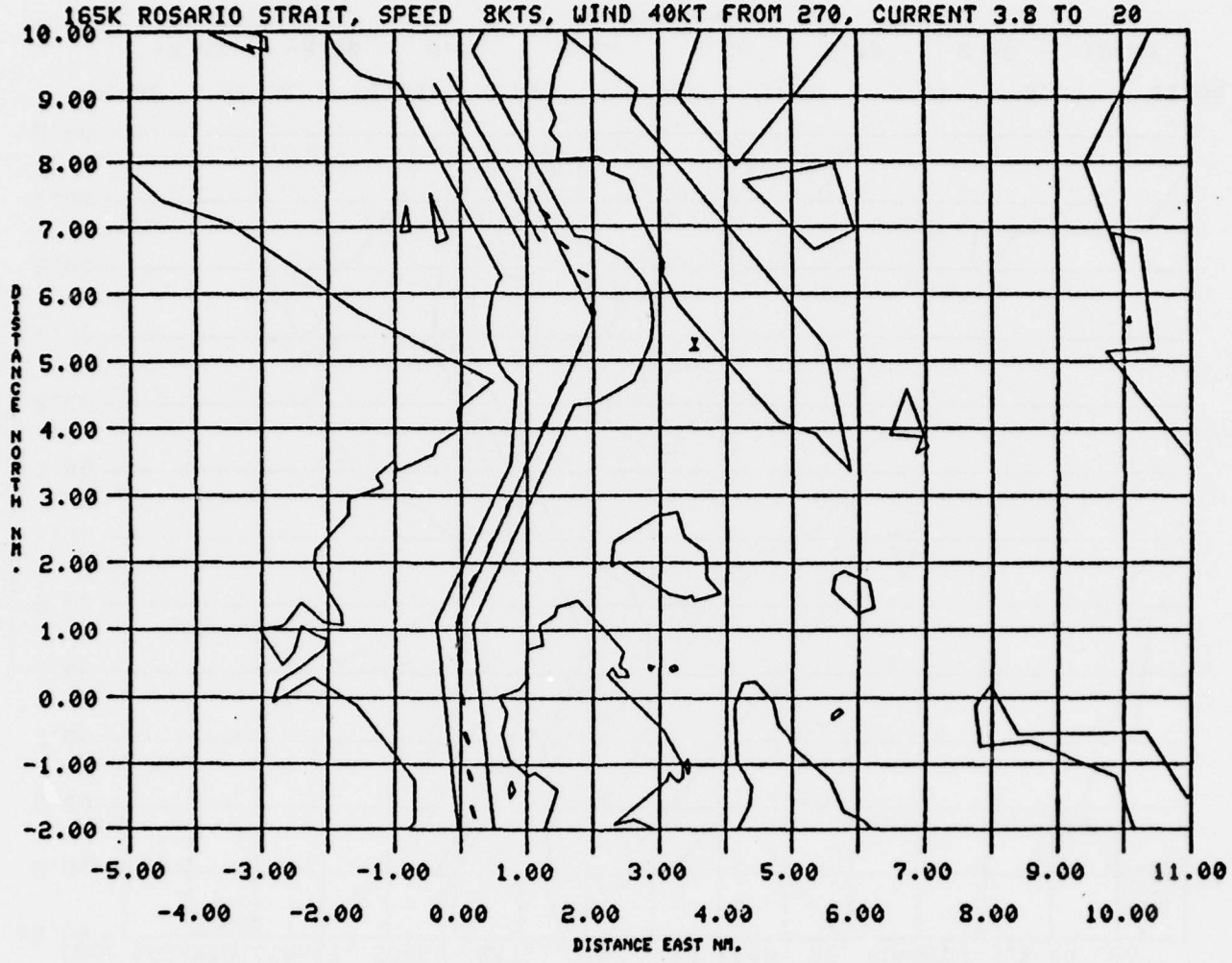

120K ROSARIO STRAIT, SPEED 6KTS, WIND 40KT FROM 90, CURRENT 3.8 TO 20
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
DISTANCE NORTH NM.
-5.00
-3.00
-1.00
1.00
3.00
5.00
7.00
9.00
11.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
DISTANCE EAST NM.

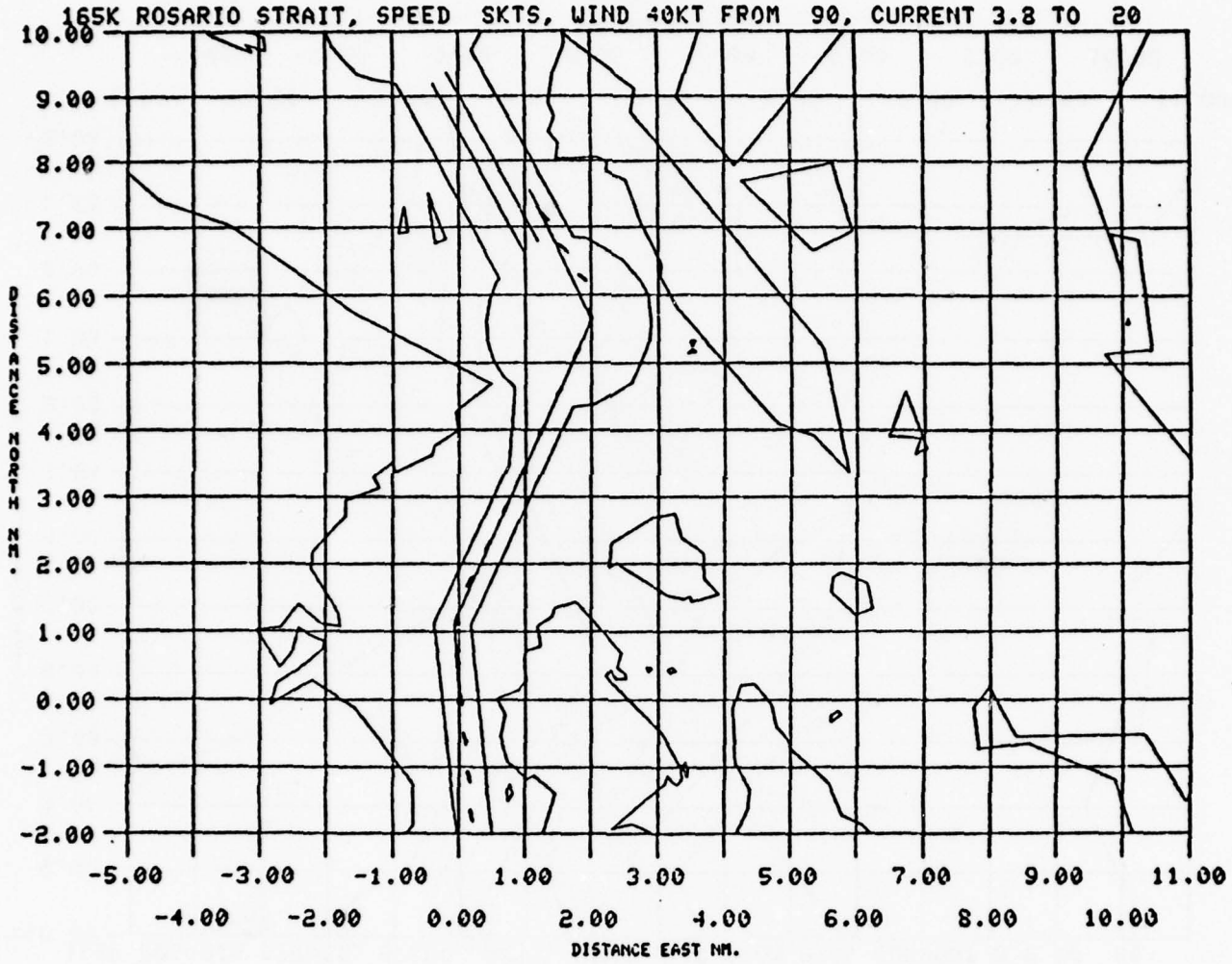

120K ROSARIO STRAIT, SPEED 4KTS, WIND 40KT FROM 270, CURRENT 3.8 TO 20
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
DISTANCE NORTH NM.
-5.00
-3.00
-1.00
1.00
3.00
5.00
7.00
9.00
11.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
DISTANCE EAST NM.

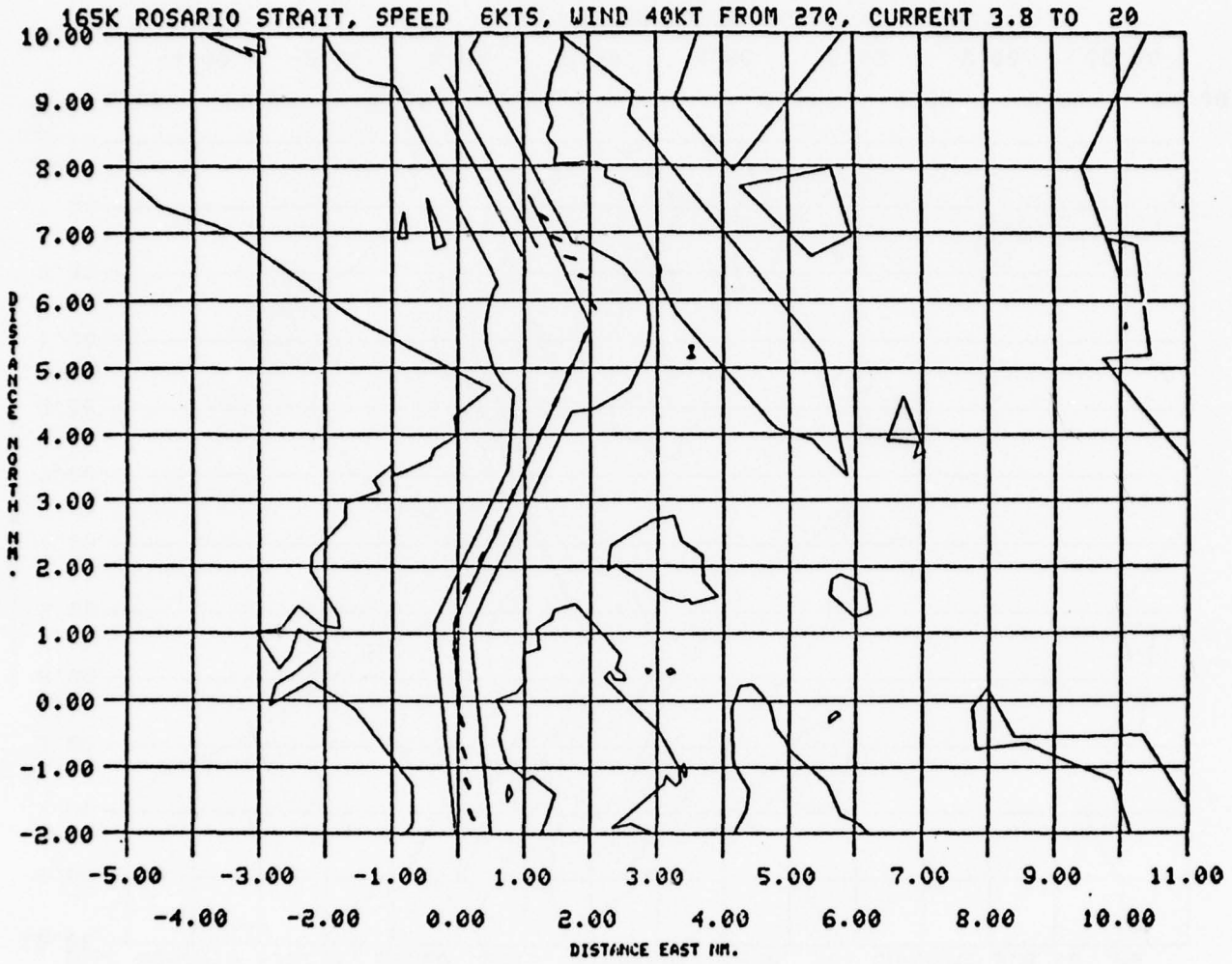

120K ROSARIO STRAIT, SPEED 4KTS, WIND 40KT FROM 90, CURRENT 3.8 TO 20
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
DISTANCE NORTH NM.
-5.00
-3.00
-1.00
1.00
3.00
5.00
7.00
9.00
11.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
DISTANCE EAST NM.

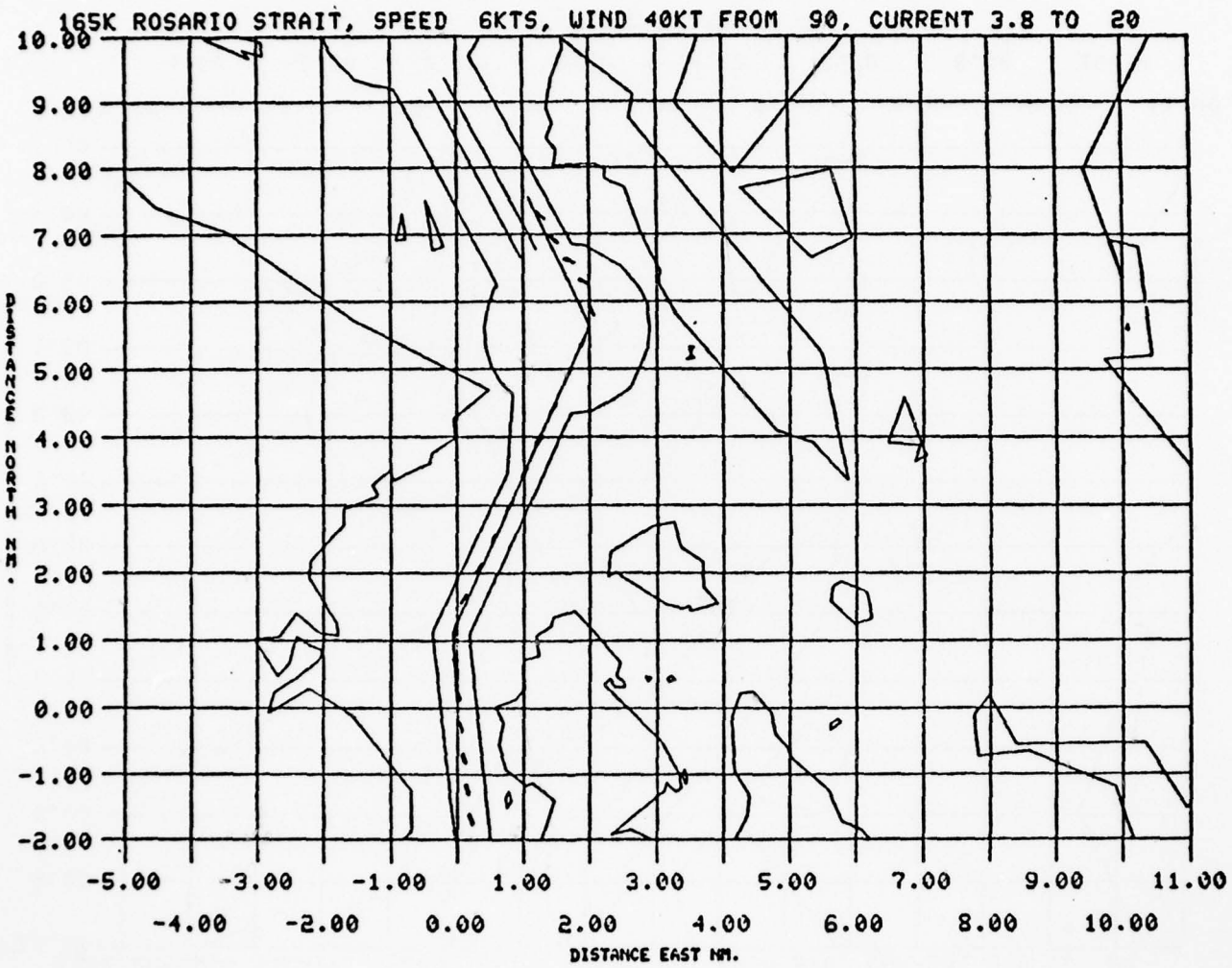

165K ROSARIO STRAIT, SPEED 10KTS, WIND 40KT FROM 270, CURRENT 4.8 TO 200
DISTANCE NORTH NM.
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-5.00
-4.00
-3.00
-2.00
-1.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
11.00
DISTANCE EAST NM.

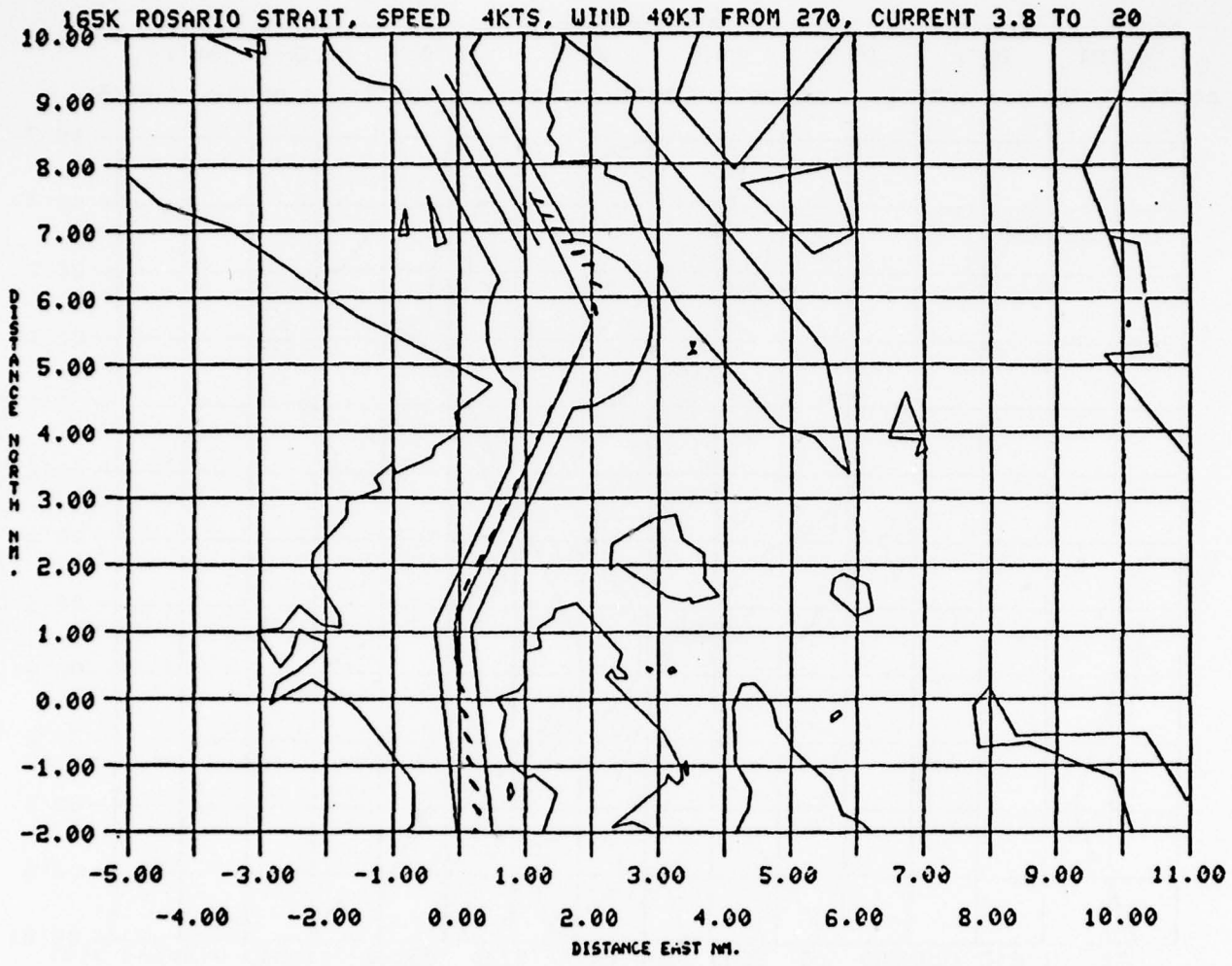

165K ROSARIO STRAIT, SPEED 10KTS, WIND 40KT FROM 90, CURRENT 4.8 TO 200
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
DISTANCE NORTH NM.
-5.00
-3.00
-1.00
1.00
3.00
5.00
7.00
9.00
11.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
DISTANCE EAST NM.

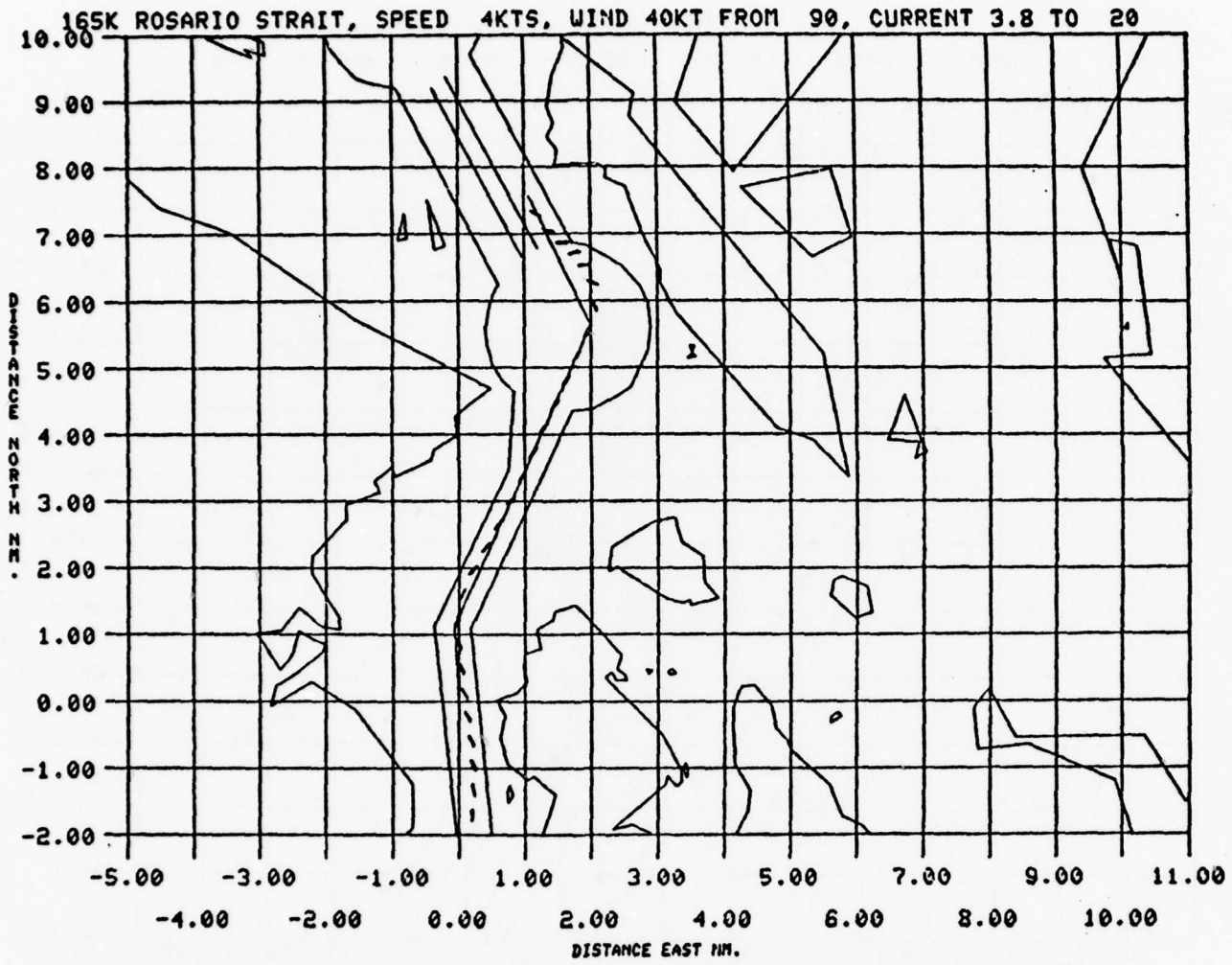

165K ROSARIO STRAIT, SPEED 8KTS, WIND 40KT FROM 270, CURRENT 3.8 TO 20
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
DISTANCE NORTH NM.
-5.00
-3.00
-1.00
1.00
3.00
5.00
7.00
9.00
11.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
DISTANCE EAST NM.

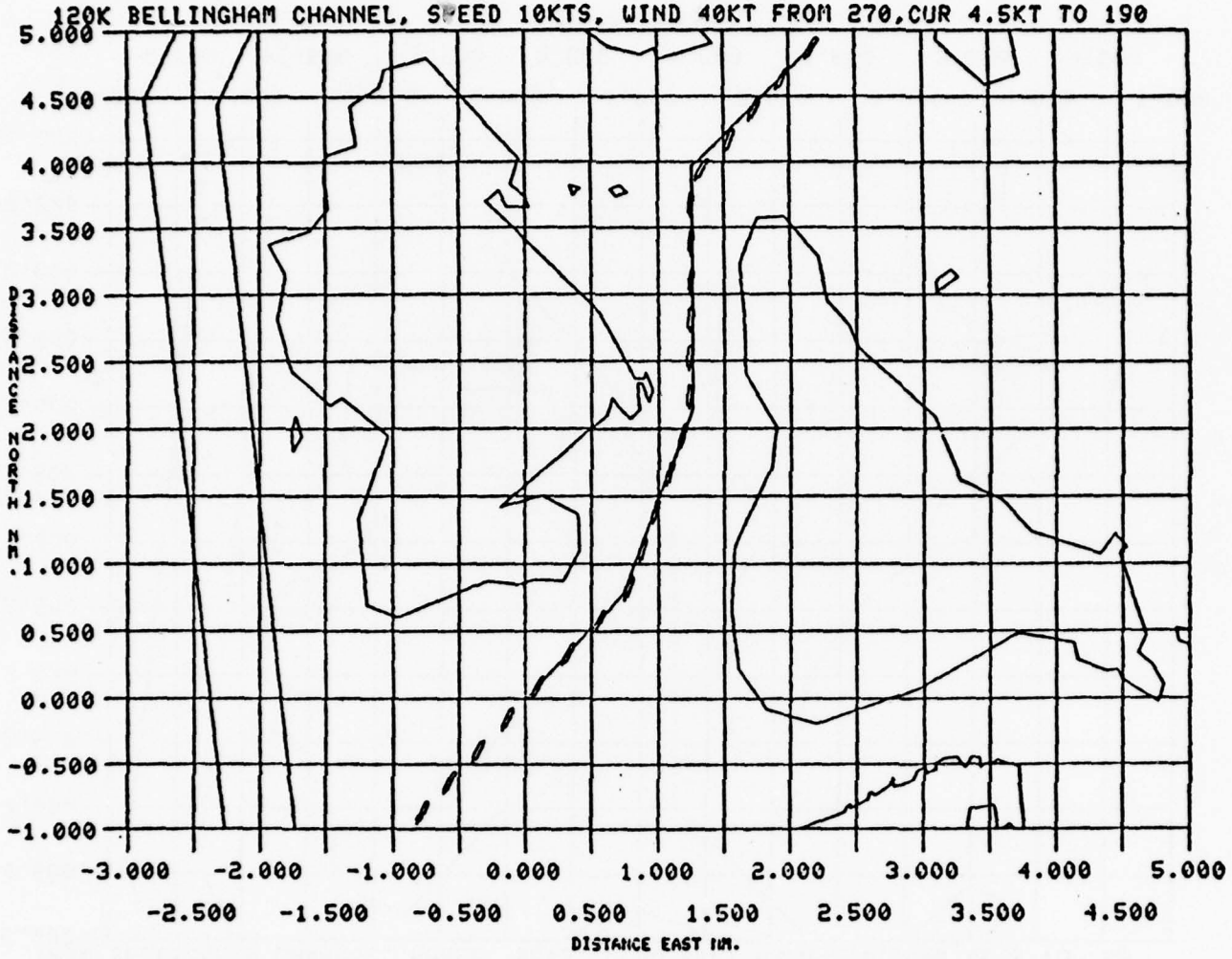

165K ROSARIO STRAIT, SPEED SKTS, WIND 40KT FROM 90, CURRENT 3.8 TO 20
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
DISTANCE NORTH NM.
-5.00
-3.00
-1.00
1.00
3.00
5.00
7.00
9.00
11.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
DISTANCE EAST NM.

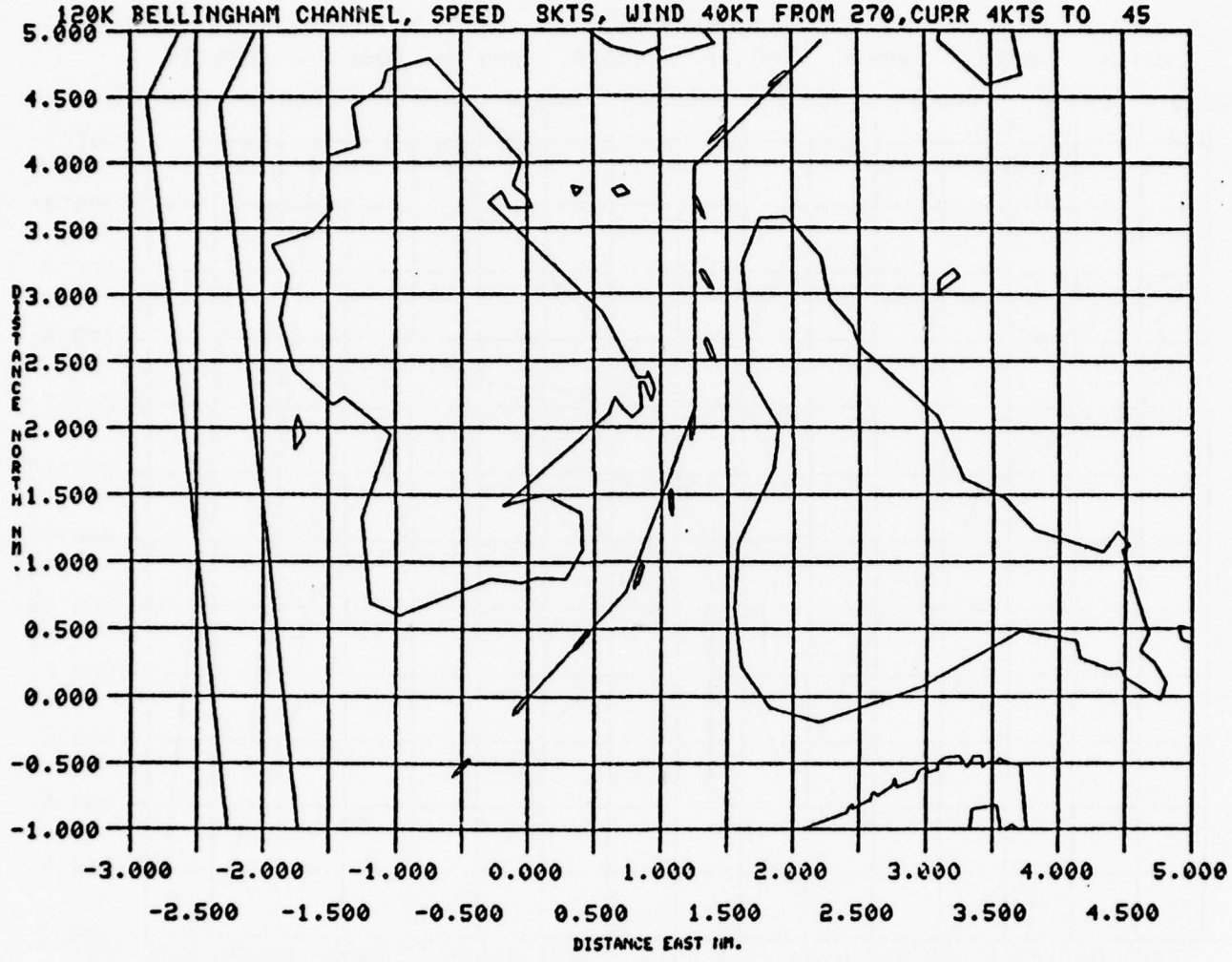

165K ROSARIO STRAIT, SPEED 6KTS, WIND 40KT FROM 270, CURRENT 3.8 TO 20
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
DISTANCE NORTH NM.
-5.00
-3.00
-1.00
1.00
3.00
5.00
7.00
9.00
11.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
DISTANCE EAST NM.

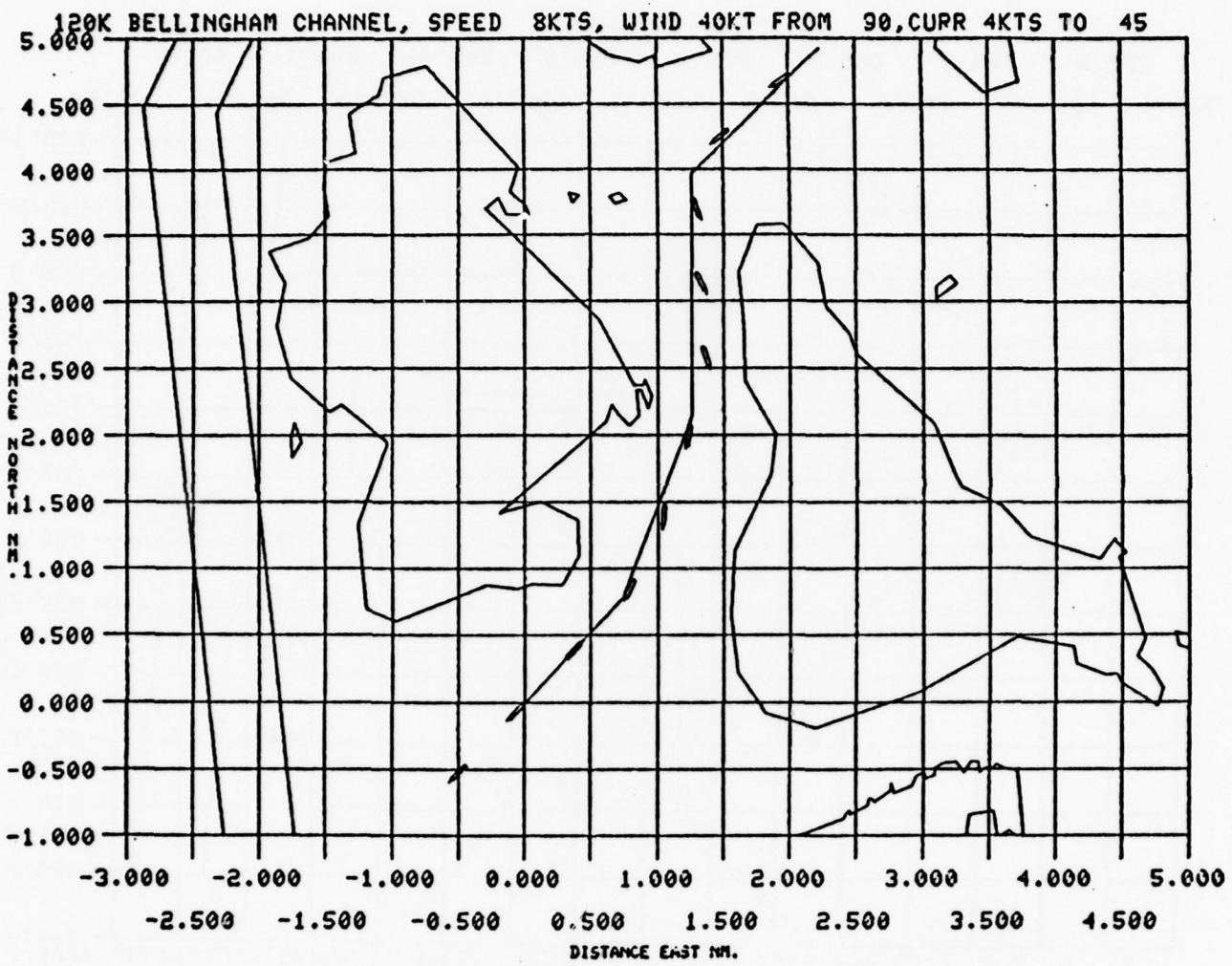

165K ROSARIO STRAIT, SPEED 6KTS, WIND 40KT FROM 90, CURRENT 3.8 TO 20
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
DISTANCE NORTH NM.
-5.00
-3.00
-1.00
1.00
3.00
5.00
7.00
9.00
11.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
DISTANCE EAST NM.

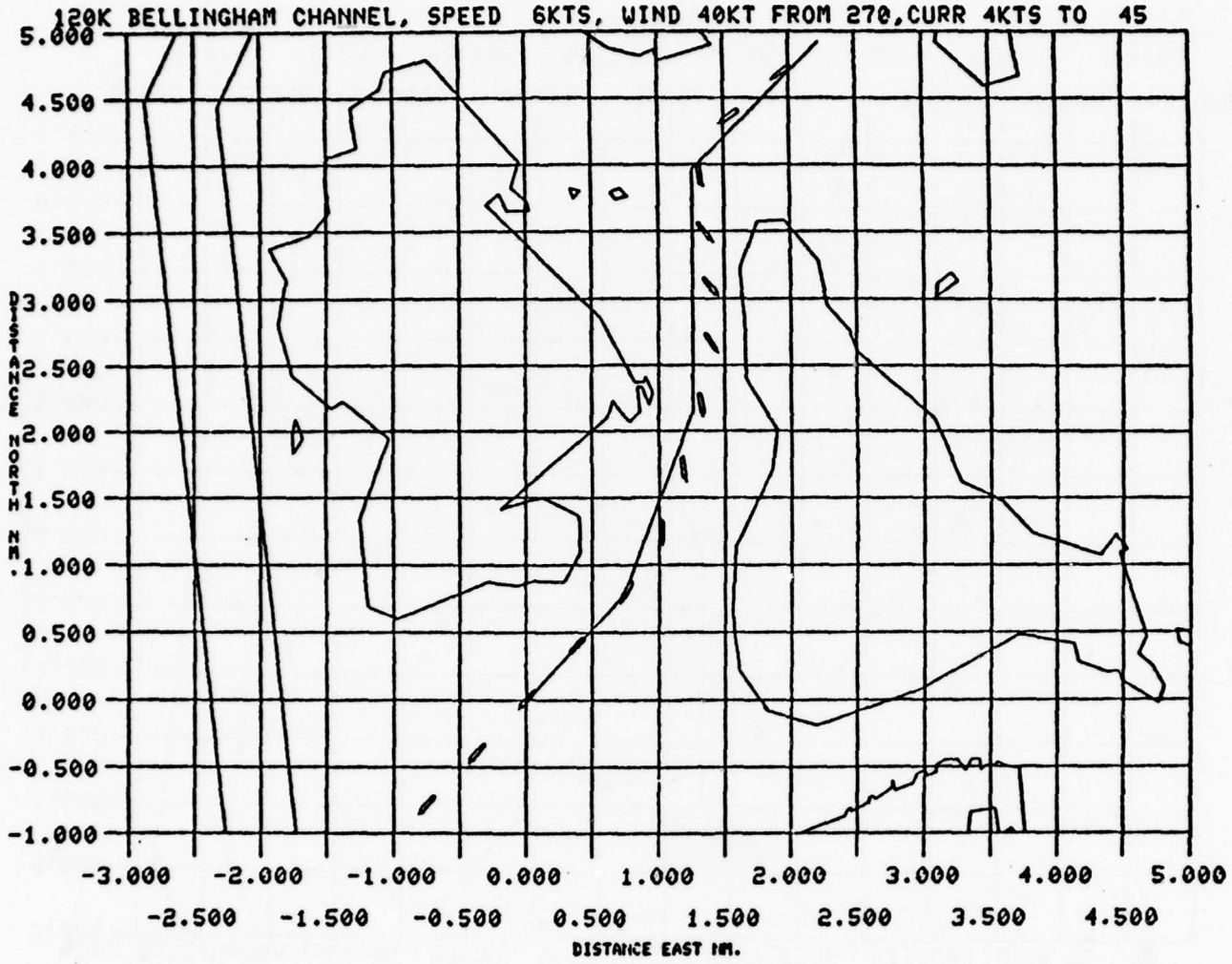

165K ROSARIO STRAIT, SPEED 4KTS, WIND 40KT FROM 270, CURRENT 3.8 TO 20
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
DISTANCE NORTH NM.
-5.00
-3.00
-1.00
1.00
3.00
5.00
7.00
9.00
11.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
DISTANCE EAST NM.

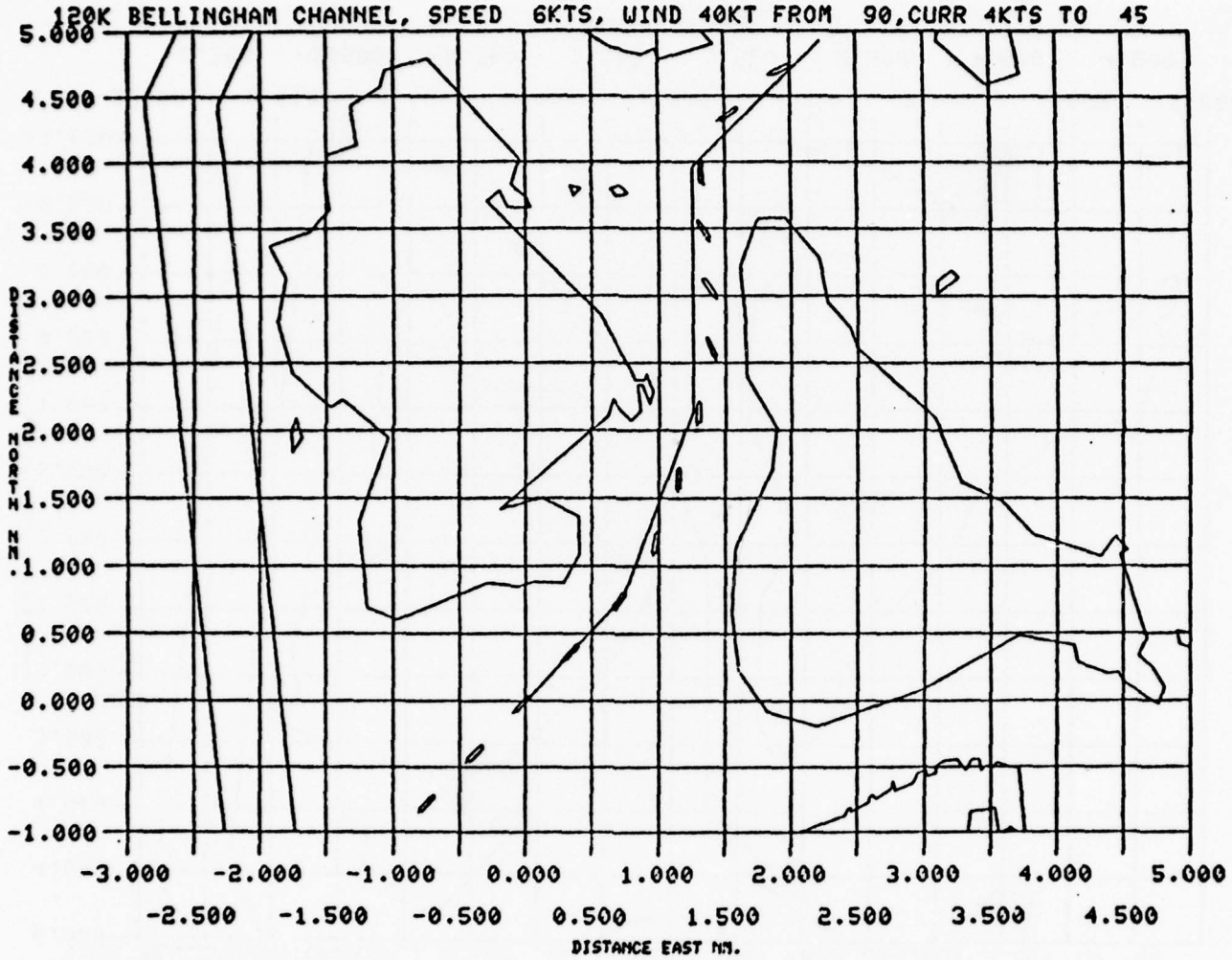

165K ROSARIO STRAIT, SPEED 4KTS, WIND 40KT FROM 90, CURRENT 3.8 TO 20
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
DISTANCE NORTH NM.
-5.00
-3.00
-1.00
1.00
3.00
5.00
7.00
9.00
11.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
DISTANCE EAST NM.

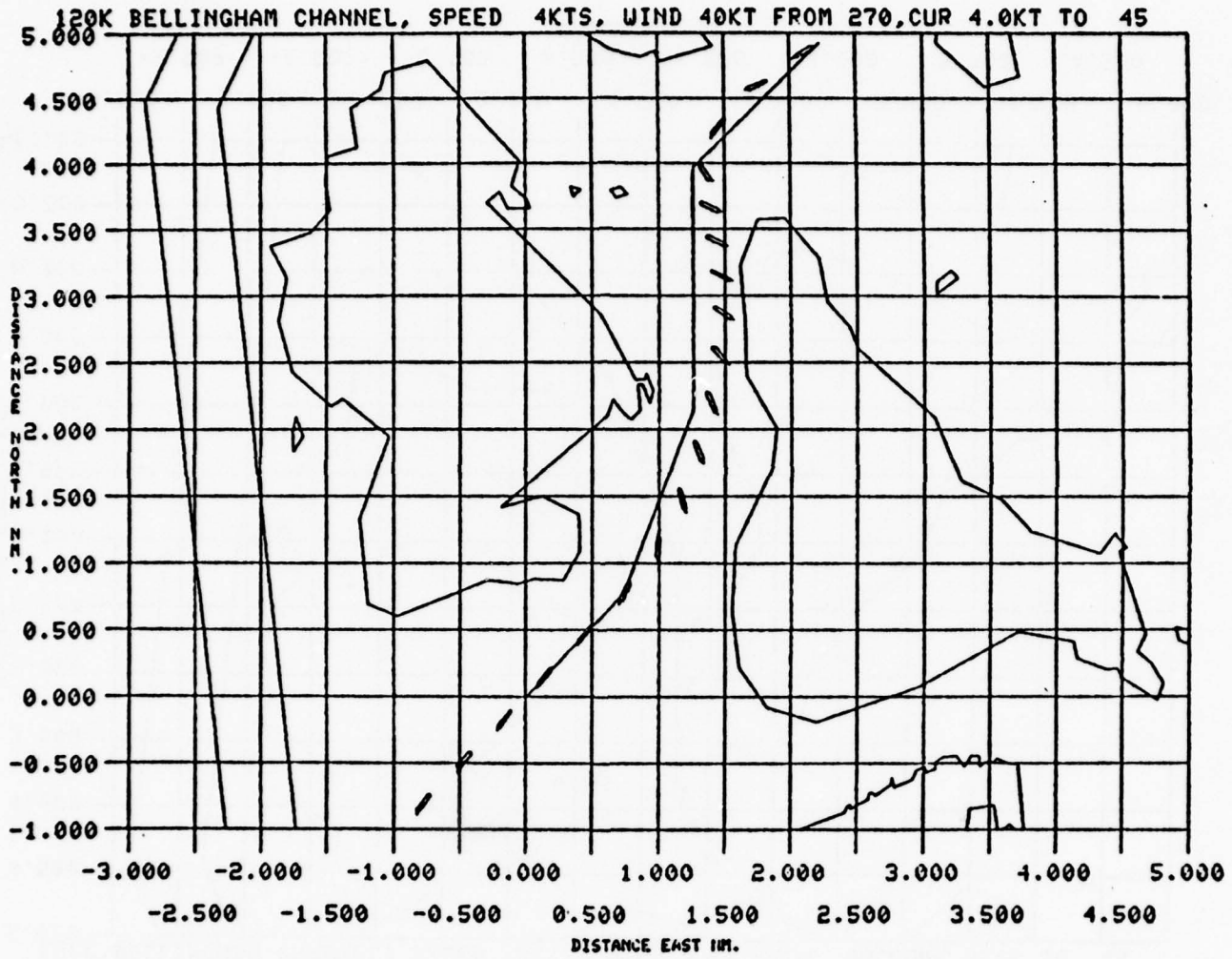

120K BELLINGHAM CHANNEL, SPEED 10KTS, WIND 40KT FROM 270,CUR 4.5KT TO 190
5.000
4.500
4.000
3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
-0.500
-1.000
DISTANCE NORTH NM.
-3.000
-2.000
-1.000
0.000
1.000
2.000
3.000
4.000
5.000
-2.500
-1.500
-0.500
0.500
1.500
2.500
3.500
4.500
DISTANCE EAST NM.

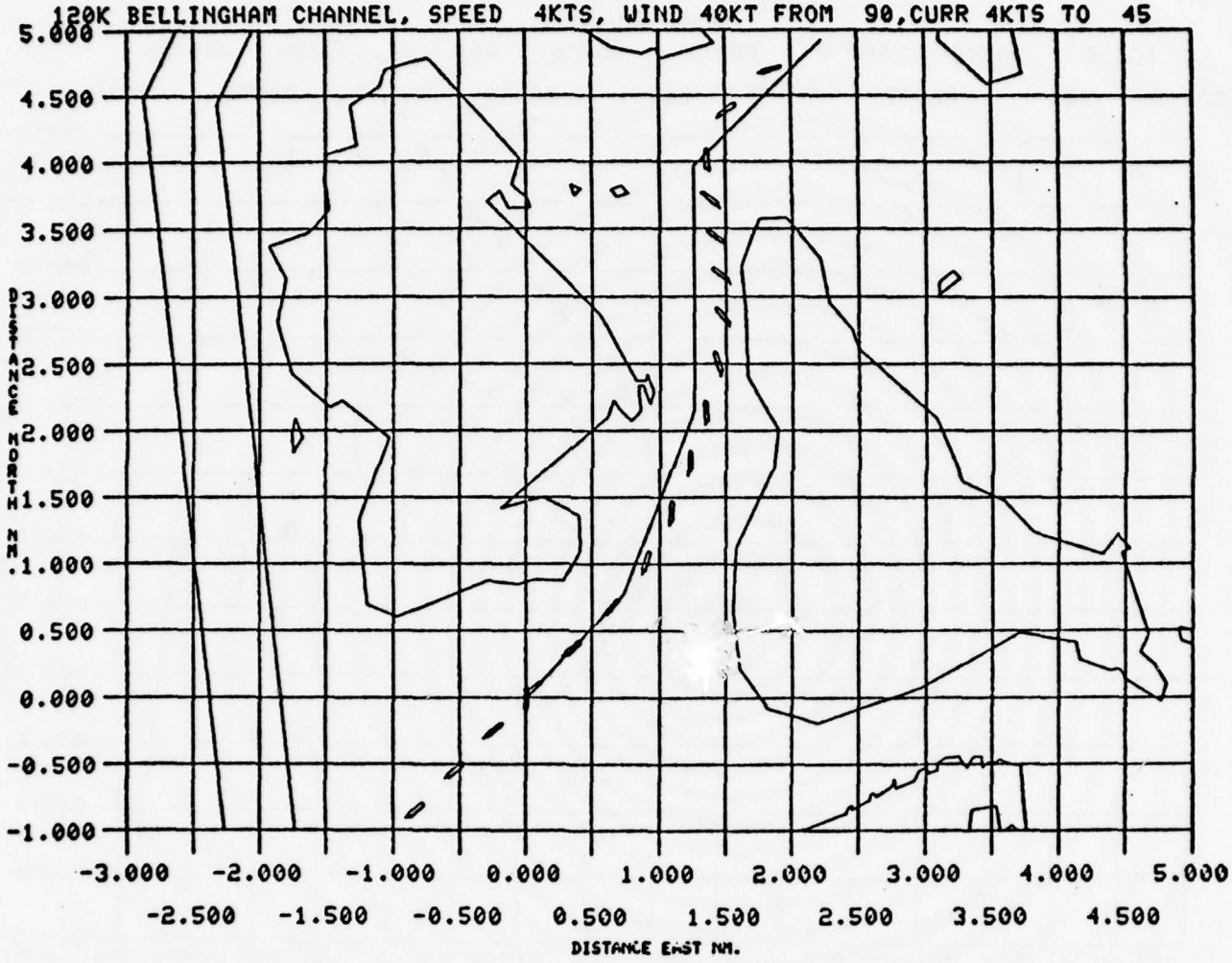

120K BELLINGHAM CHANNEL, SPEED 8KTS, WIND 40KT FROM 270,CURR 4KTS TO 45
5.000
4.500
4.000
3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
-0.500
-1.000
DISTANCE NORTH NM.
-3.000
-2.000
-1.000
0.000
1.000
2.000
3.000
4.000
5.000
-2.500
-1.500
-0.500
0.500
1.500
2.500
3.500
4.500
DISTANCE EAST NM.

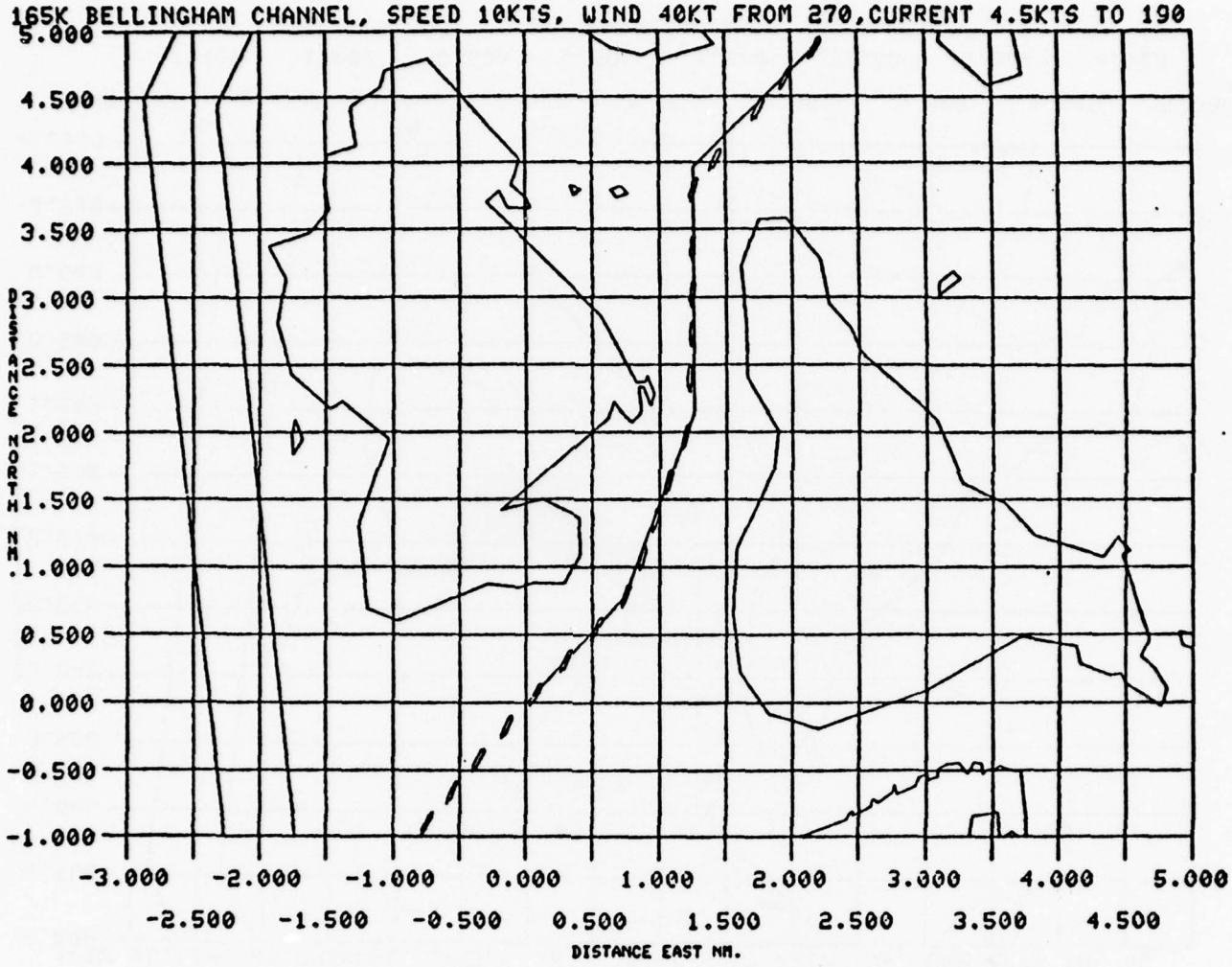

120K BELLINGHAM CHANNEL, SPEED 8KTS, WIND 40KT FROM 90,CURR 4KTS TO 45
5.000
4.500
4.000
3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
-0.500
-1.000
DISTANCE NORTH NM.
-3.000
-2.000
-1.000
0.000
1.000
2.000
3.000
4.000
5.000
-2.500
-1.500
-0.500
0.500
1.500
2.500
3.500
4.500
DISTANCE EAST NM.

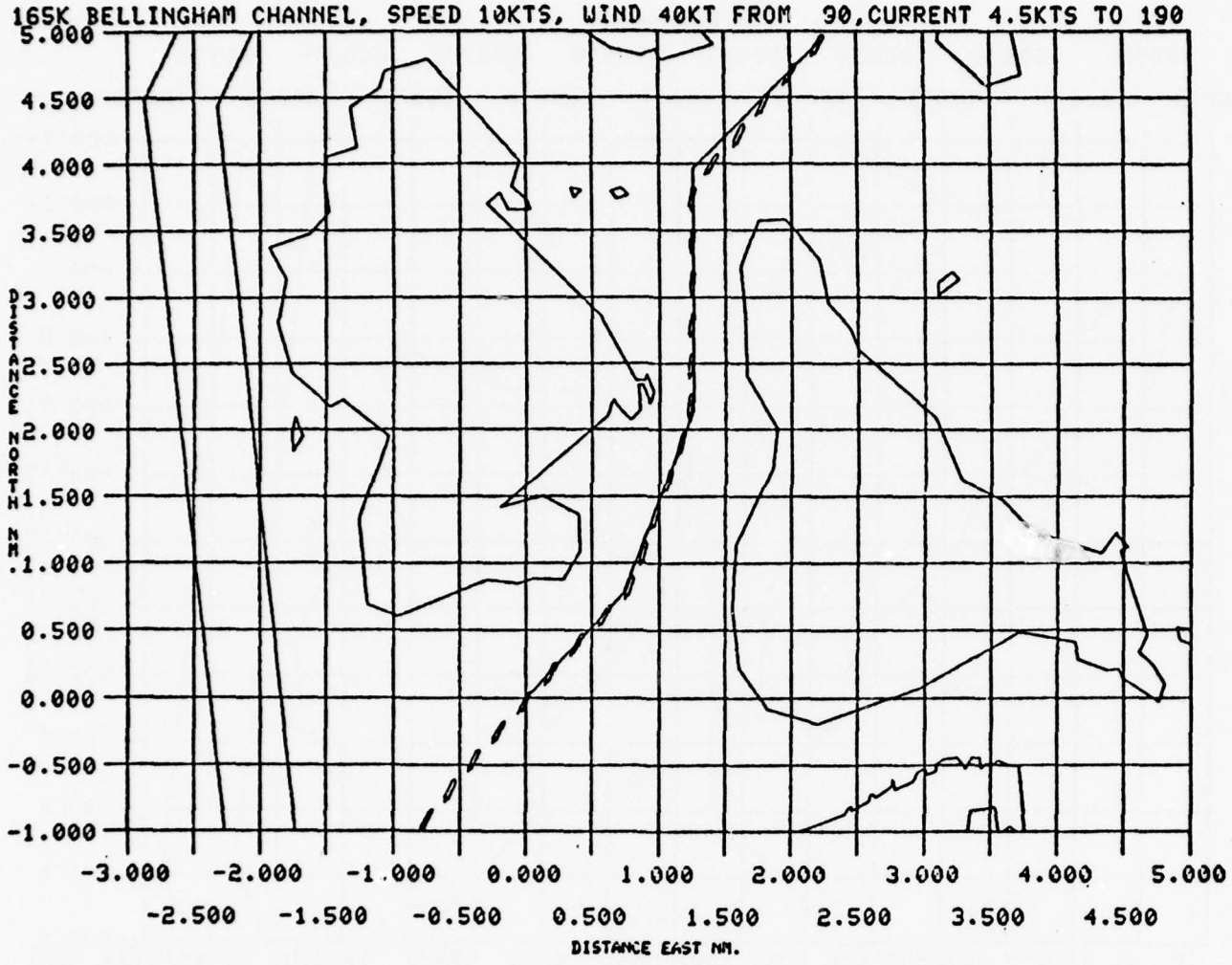

120K BELLINGHAM CHANNEL, SPEED 6KTS, WIND 40KT FROM 270,CURR 4KTS TO 45
5.000
4.500
4.000
3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
-0.500
-1.000
DISTANCE NORTH NM.
-3.000
-2.000
-1.000
0.000
1.000
2.000
3.000
4.000
5.000
-2.500
-1.500
-0.500
0.500
1.500
2.500
3.500
4.500
DISTANCE EAST NM.

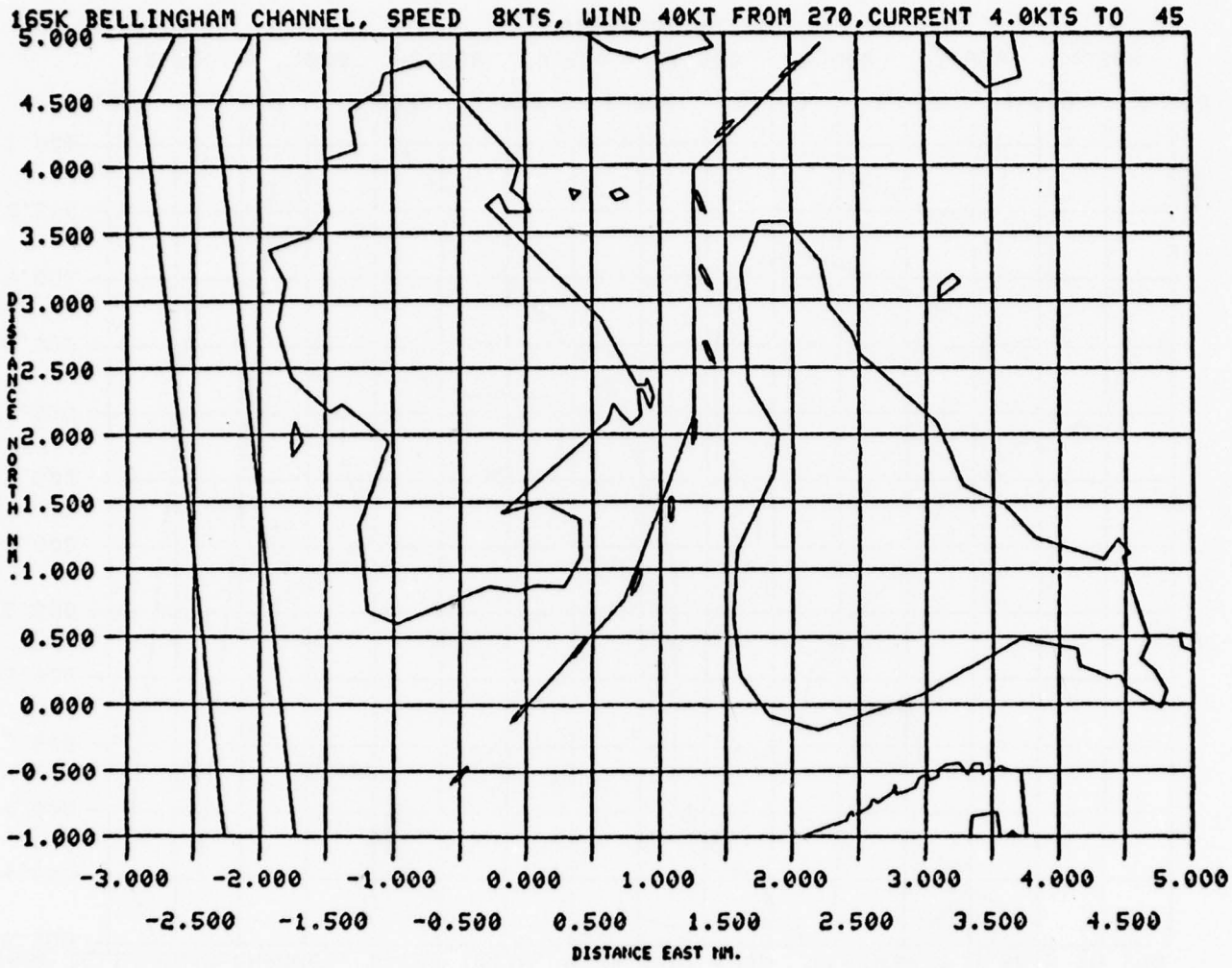

120K BELLINGHAM CHANNEL, SPEED 6KTS, WIND 40KT FROM 90,CURR 4KTS TO 45
5.000
4.500
4.000
3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
-0.500
-1.000
DISTANCE NORTH NM.
-3.000
-2.000
-1.000
0.000
1.000
2.000
3.000
4.000
5.000
-2.500
-1.500
-0.500
0.500
1.500
2.500
3.500
4.500
DISTANCE EAST NM.

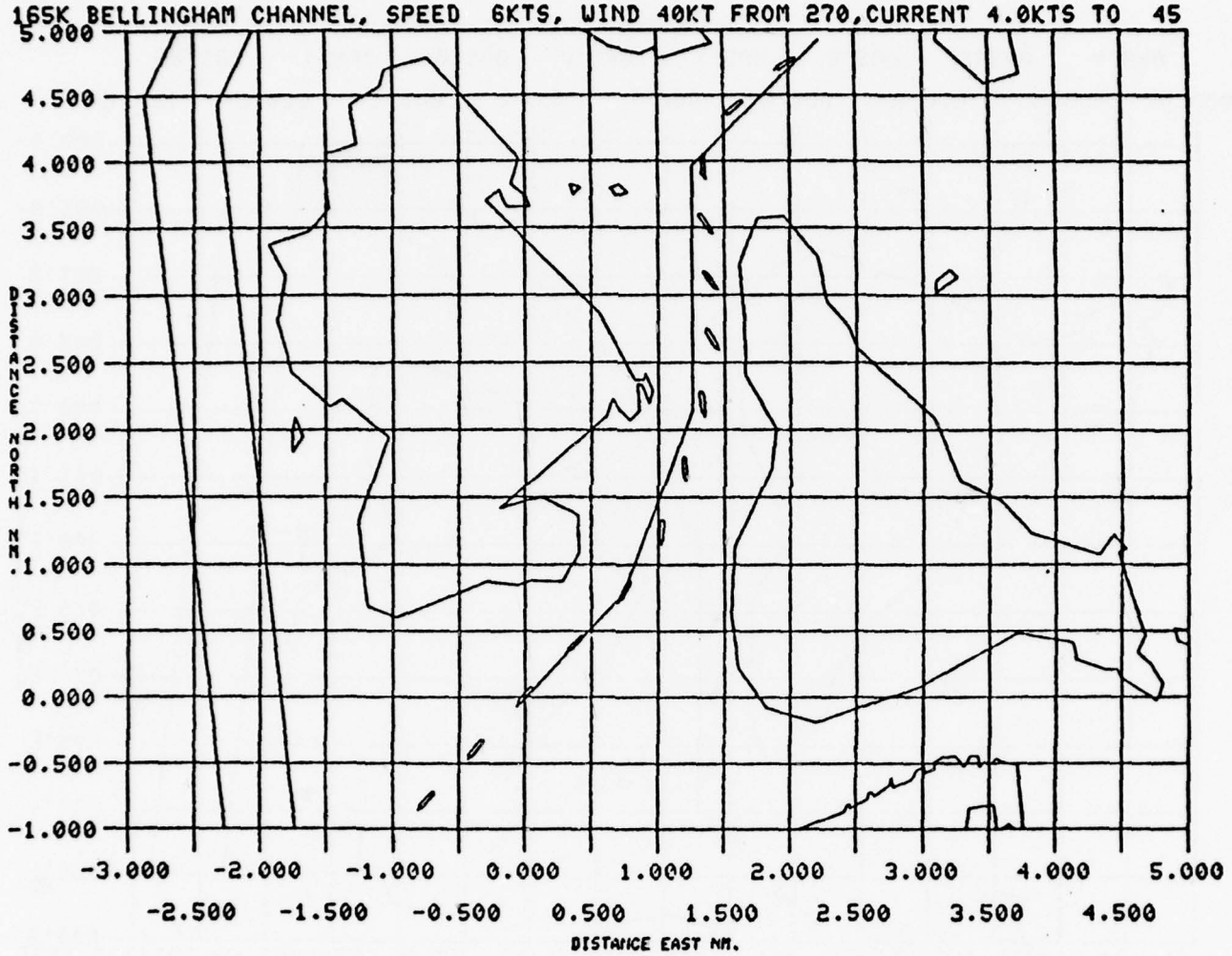

120K BELLINGHAM CHANNEL, SPEED 4KTS, WIND 40KT FROM 270,CUR 4.0KT TO 45
5.000
4.500
4.000
3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
-0.500
-1.000
DISTANCE NORTH NM.
-3.000
-2.000
-1.000
0.000
1.000
2.000
3.000
4.000
5.000
-2.500
-1.500
-0.500
0.500
1.500
2.500
3.500
4.500
DISTANCE EAST NM.

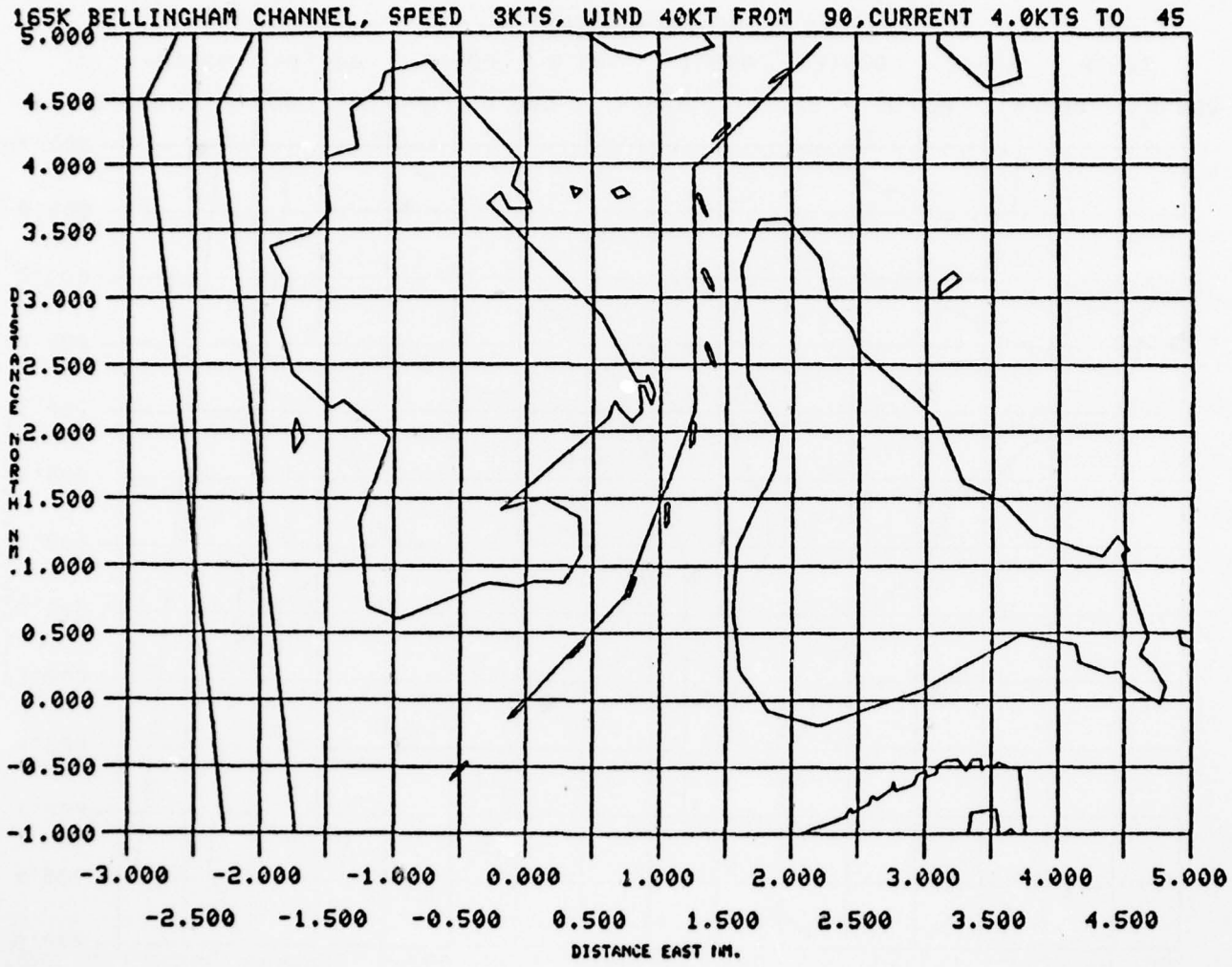

120K BELLINGHAM CHANNEL, SPEED 4KTS, WIND 40KT FROM 90,CURR 4KTS TO 45
5.000
4.500
4.000
3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
-0.500
-1.000
DISTANCE NORTH NM.
-3.000
-2.000
-1.000
0.000
1.000
2.000
3.000
4.000
5.000
-2.500
-1.500
-0.500
0.500
1.500
2.500
3.500
4.500
DISTANCE EAST NM.

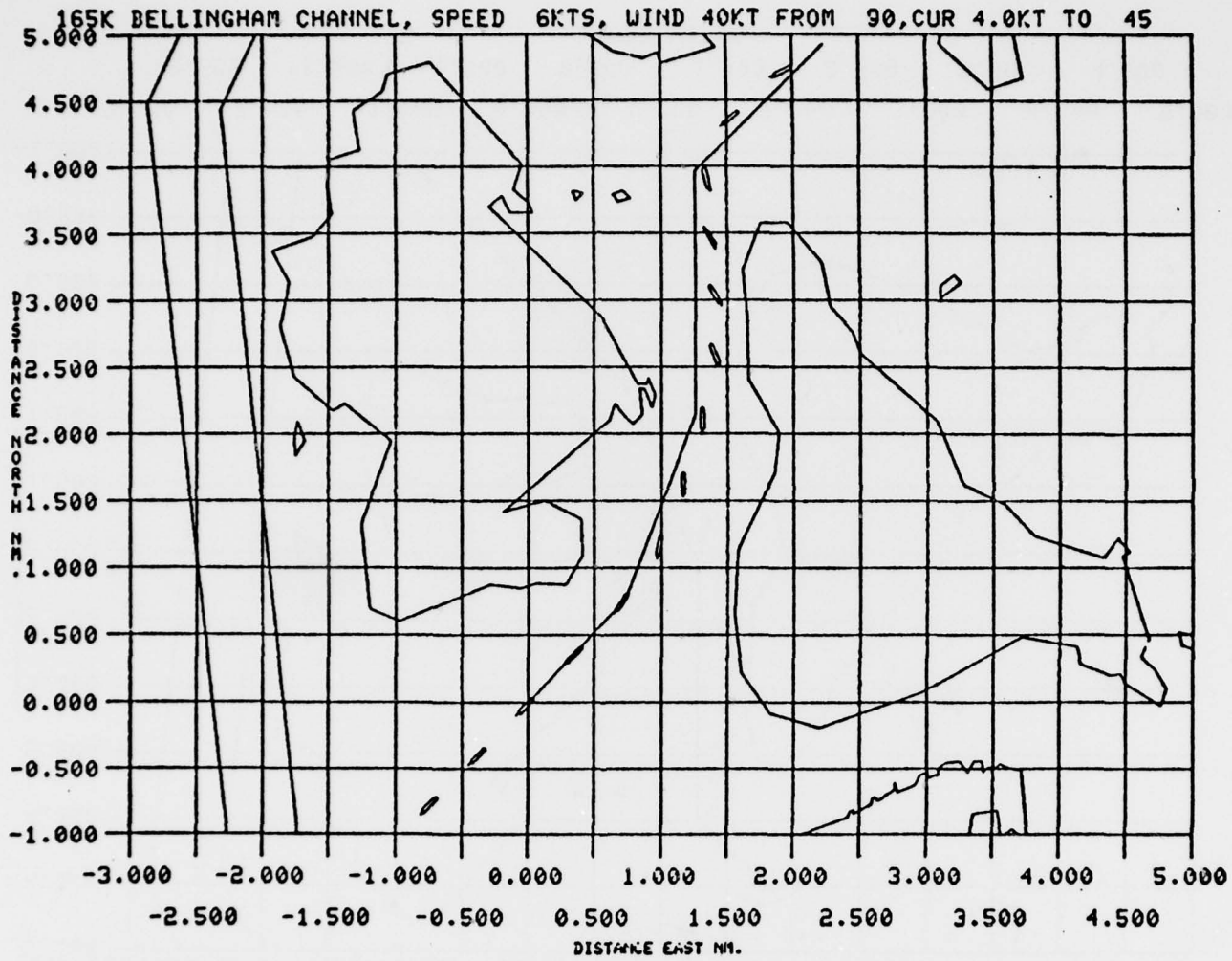

165K BELLINGHAM CHANNEL, SPEED 10KTS, WIND 40KT FROM 270,CURRENT 4.5KTS TO 190
5.000
4.500
4.000
3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
-0.500
-1.000
DISTANCE NORTH NM.
-3.000
-2.000
-1.000
0.000
1.000
2.000
3.000
4.000
5.000
-2.500
-1.500
-0.500
0.500
1.500
2.500
3.500
4.500
DISTANCE EAST NM.

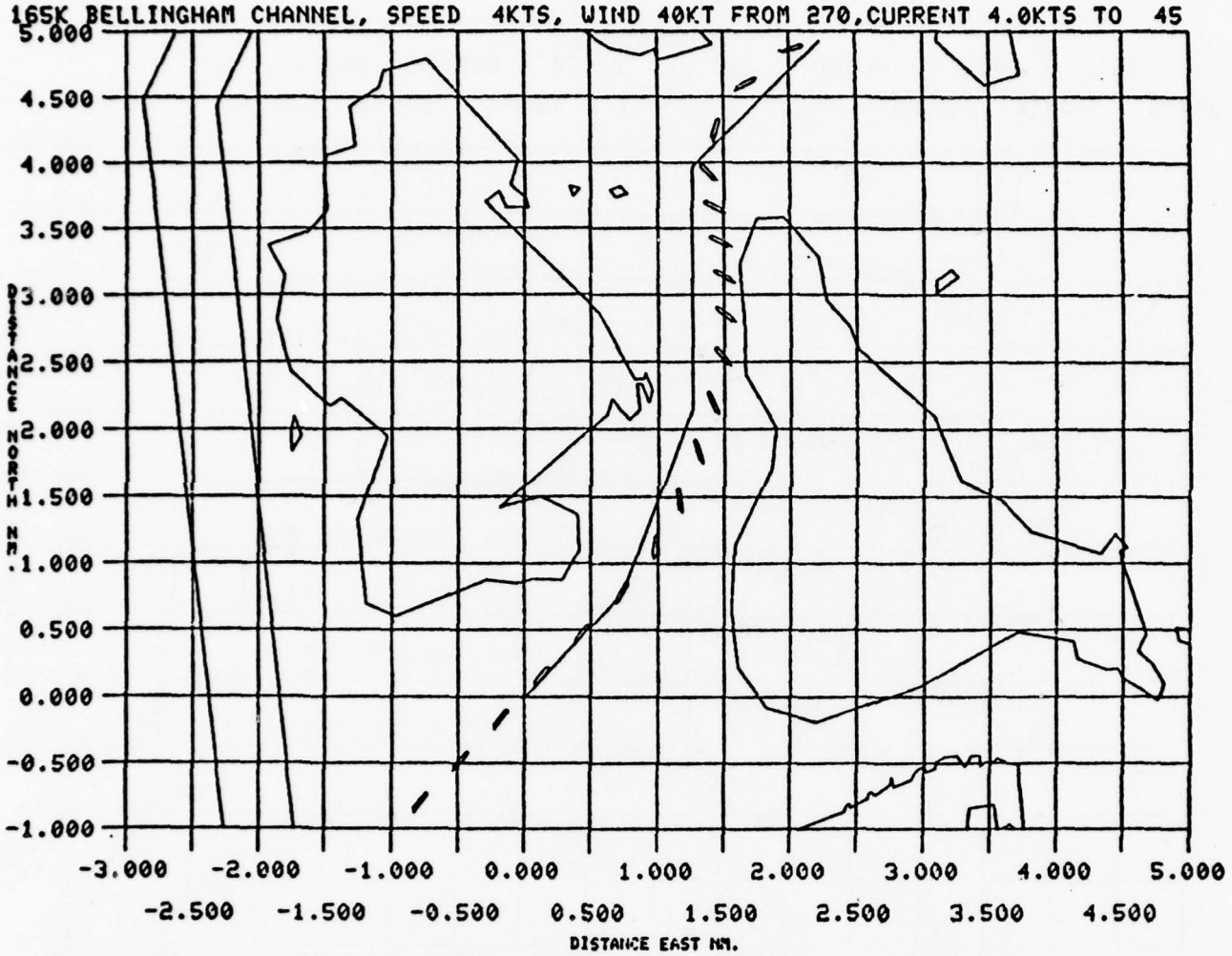

165K BELLINGHAM CHANNEL, SPEED 10KTS, WIND 40KT FROM 90,CURRENT 4.5KTS TO 190
5.000
4.500
4.000
3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
-0.500
-1.000
DISTANCE NORTH NM.
-3.000
-2.000
-1.000
0.000
1.000
2.000
3.000
4.000
5.000
-2.500
-1.500
-0.500
0.500
1.500
2.500
3.500
4.500
DISTANCE EAST NM.

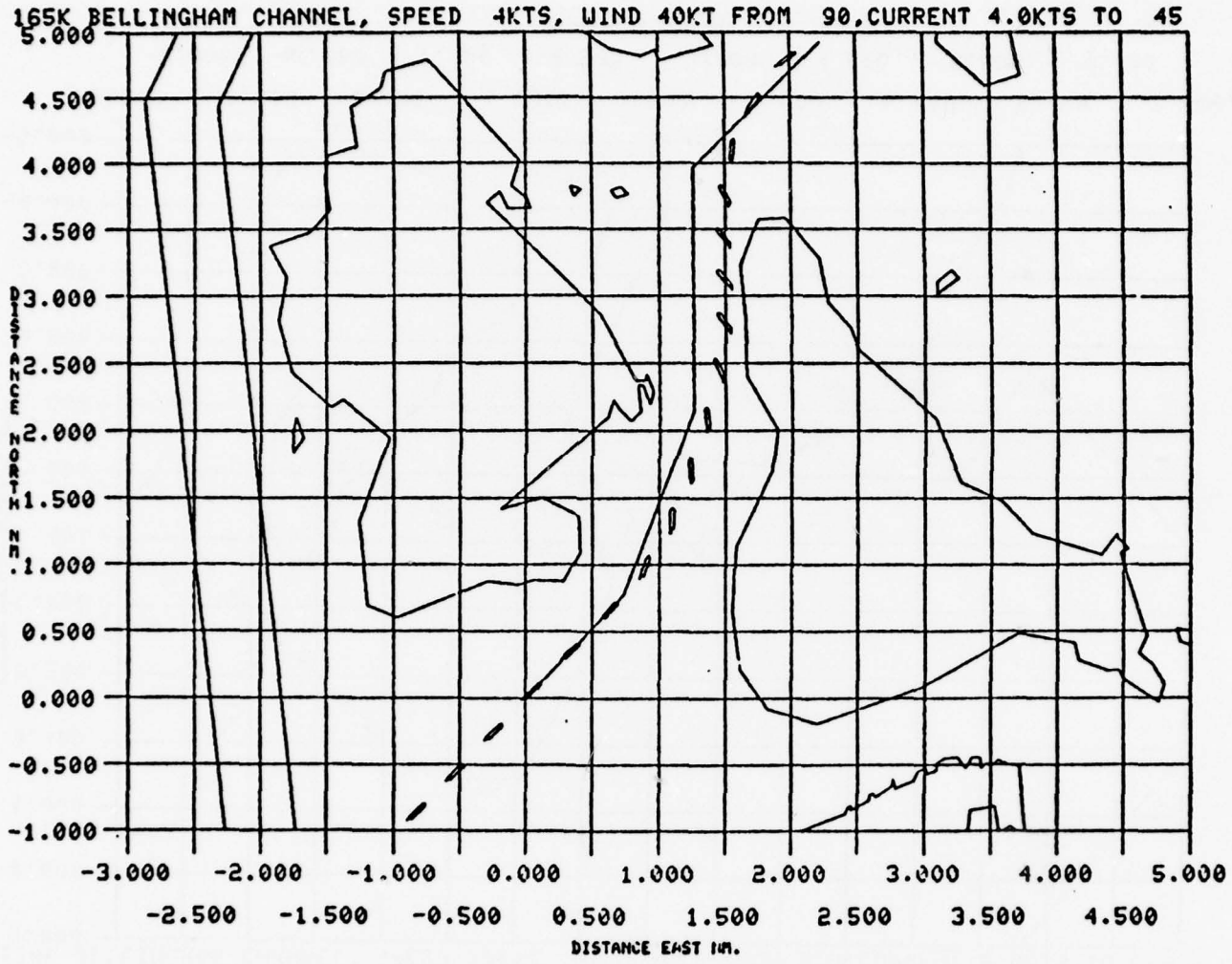

165K BELLINGHAM CHANNEL, SPEED 8KTS, WIND 40KT FROM 270,CURRENT 4.0KTS TO 45
5.000
4.500
4.000
3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
-0.500
-1.000
DISTANCE NORTH NM.
-3.000
-2.000
-1.000
0.000
1.000
2.000
3.000
4.000
5.000
-2.500
-1.500
-0.500
0.500
1.500
2.500
3.500
4.500
DISTANCE EAST NM.

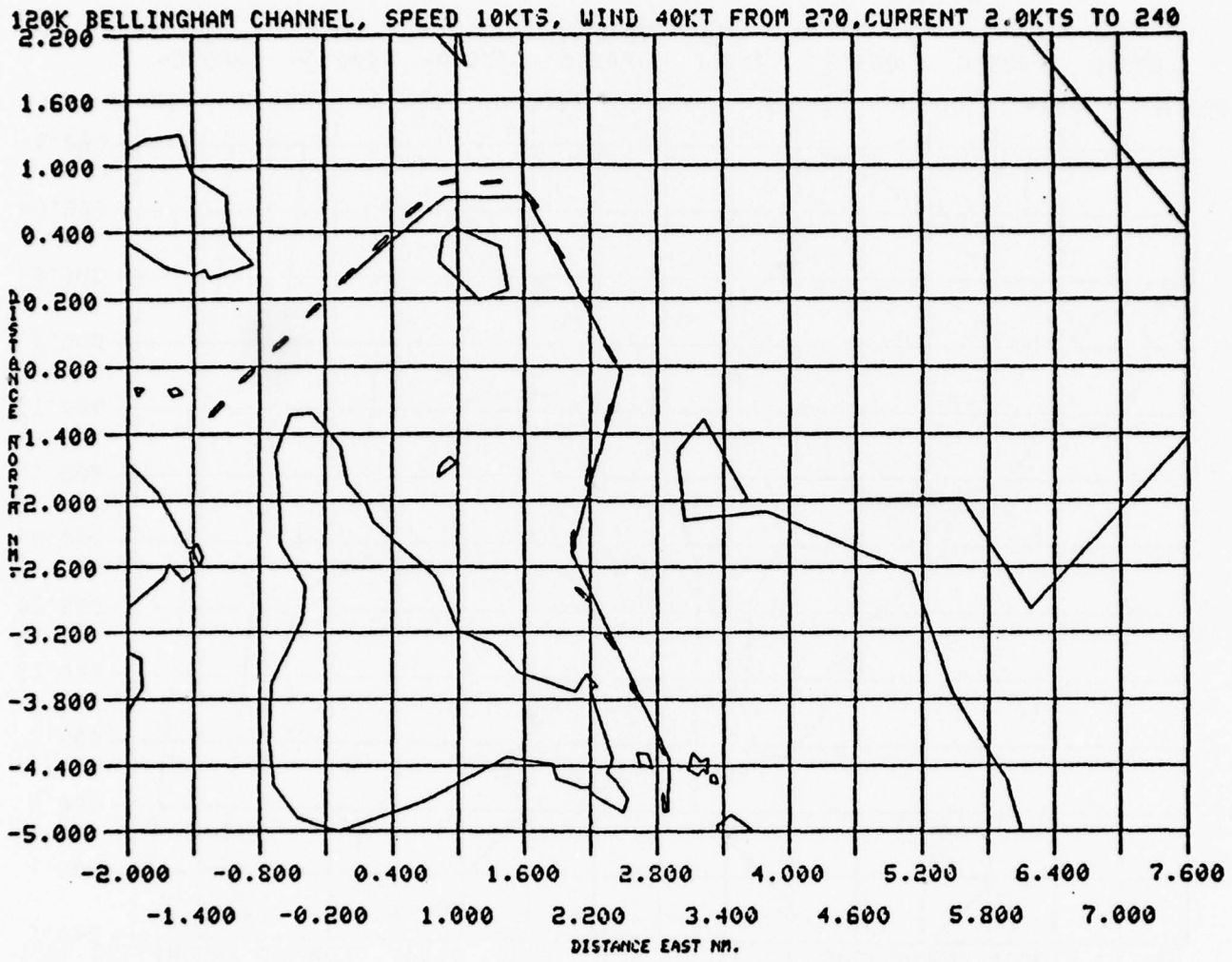

165K BELLINGHAM CHANNEL, SPEED 6KTS, WIND 40KT FROM 270,CURRENT 4.0KTS TO 45
5.000
4.500
4.000
3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
-0.500
-1.000
DISTANCE NORTH NM.
-3.000
-2.000
-1.000
0.000
1.000
2.000
3.000
4.000
5.000
-2.500
-1.500
-0.500
0.500
1.500
2.500
3.500
4.500
DISTANCE EAST NM.

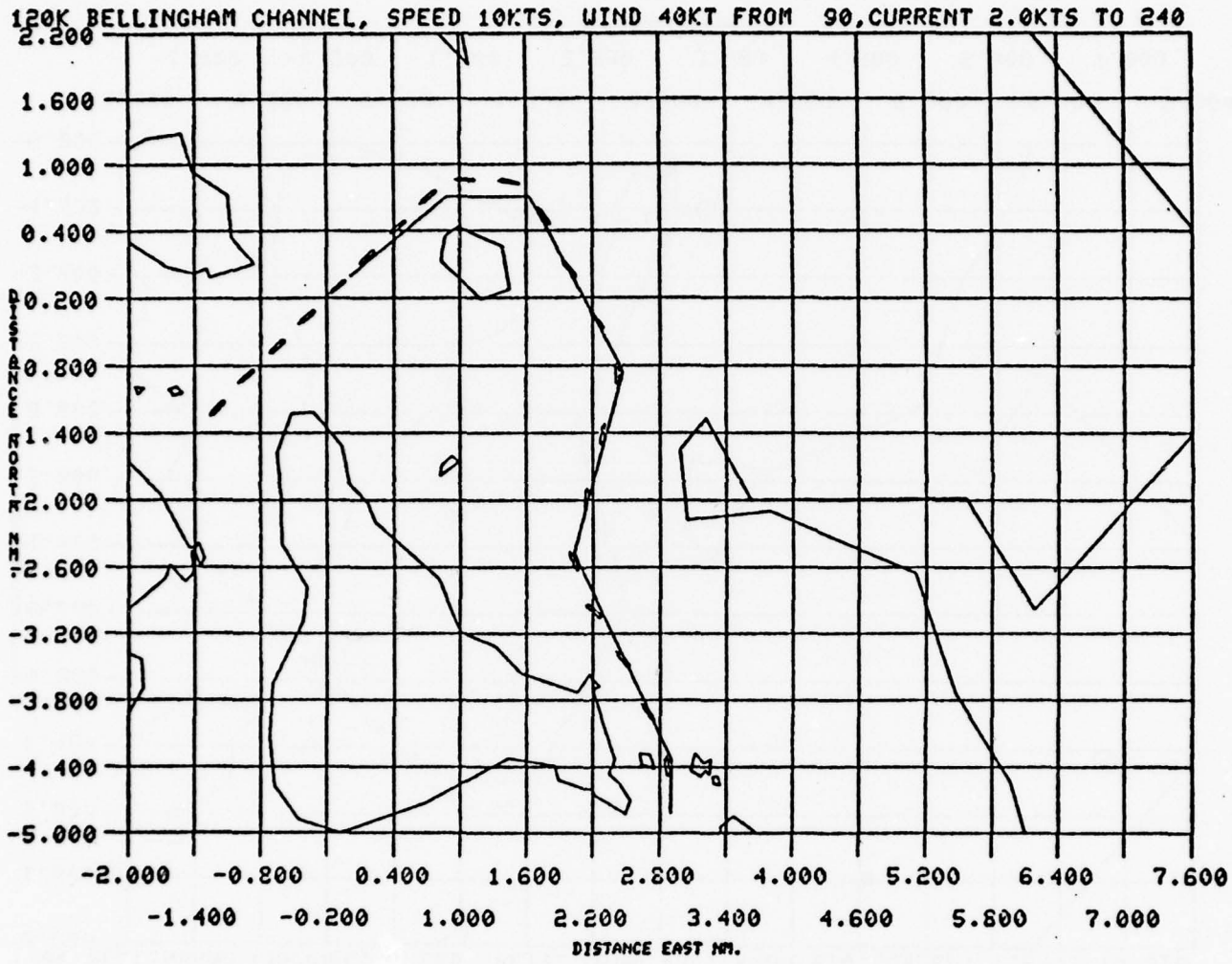

165K BELLINGHAM CHANNEL, SPEED 8KTS, WIND 40KT FROM 90,CURRENT 4.0KTS TO 45
5.000
4.500
4.000
3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
-0.500
-1.000
DISTANCE NORTH NM.
-3.000
-2.000
-1.000
0.000
1.000
2.000
3.000
4.000
5.000
-2.500
-1.500
-0.500
0.500
1.500
2.500
3.500
4.500
DISTANCE EAST NM.

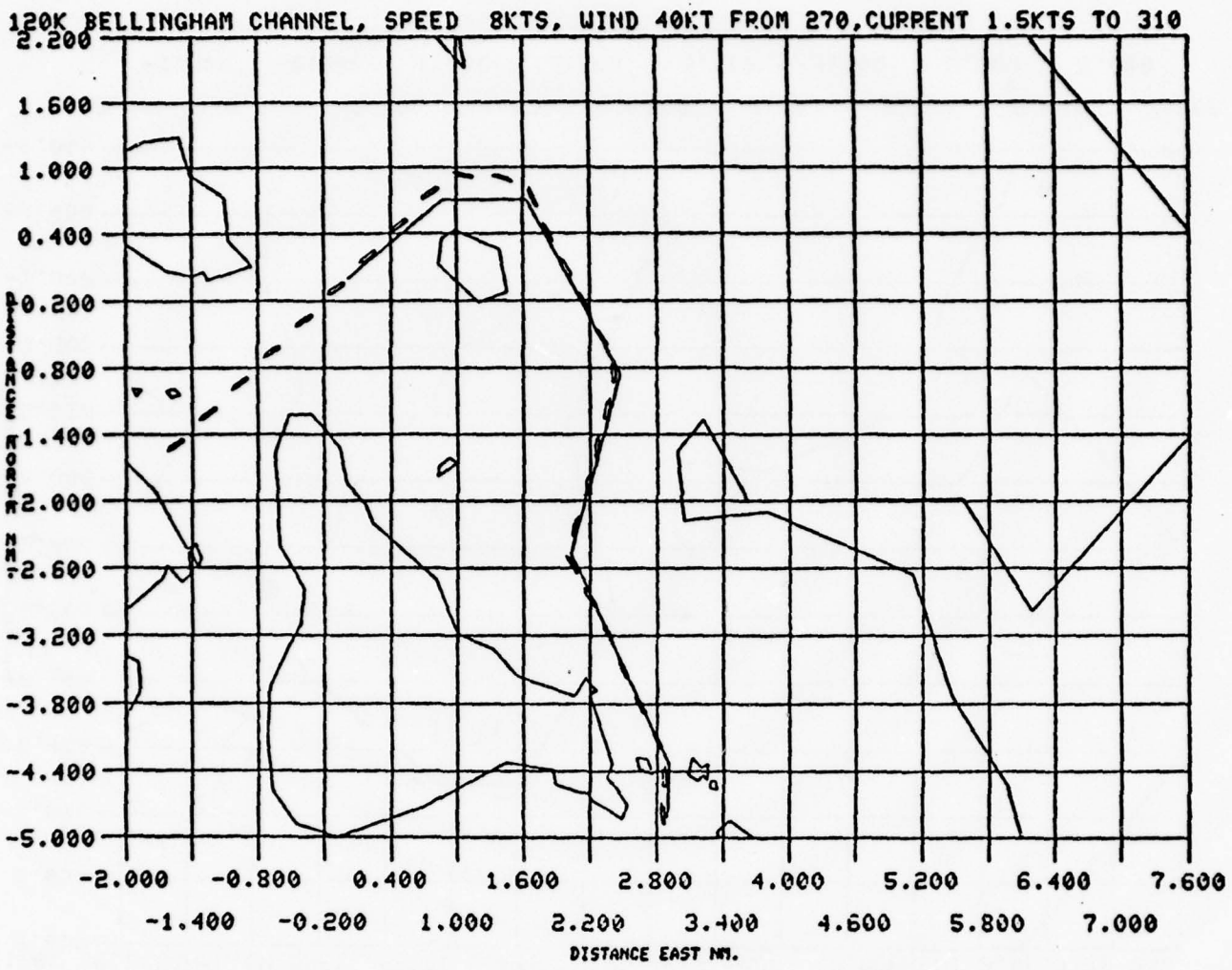

165K BELLINGHAM CHANNEL, SPEED 6KTS, WIND 40KT FROM 90,CUR 4.0KT TO 45
5.000
4.500
4.000
3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
-0.500
-1.000
DISTANCE NORTH NM.
-3.000
-2.000
-1.000
0.000
1.000
2.000
3.000
4.000
5.000
-2.500
-1.500
-0.500
0.500
1.500
2.500
3.500
4.500
DISTANCE EAST NM.

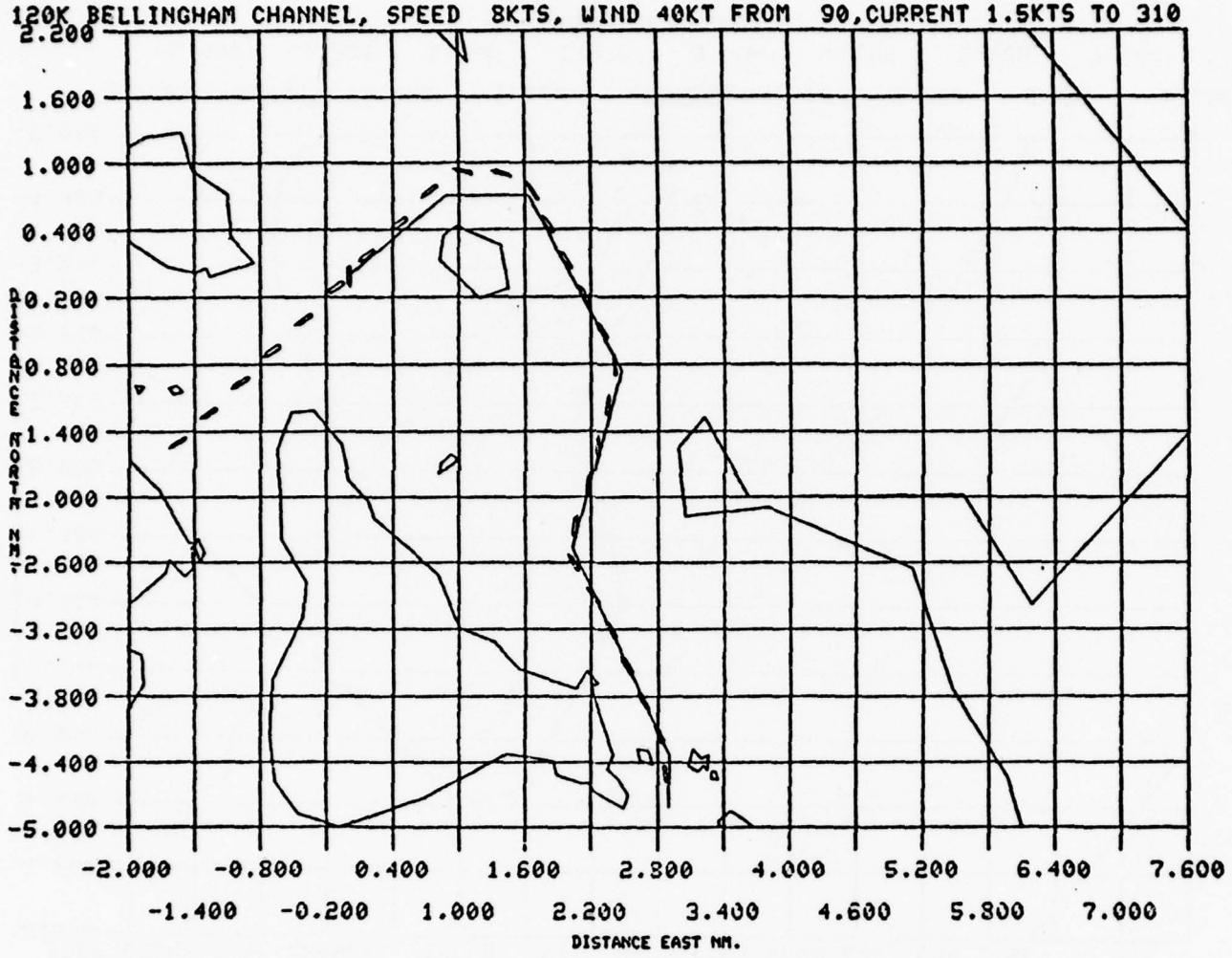

165K BELLINGHAM CHANNEL, SPEED 4KTS, WIND 40KT FROM 270,CURRENT 4.0KTS TO 45
5.000
4.500
4.000
3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
-0.500
-1.000
DISTANCE NORTH NM.
-3.000
-2.000
-1.000
0.000
1.000
2.000
3.000
4.000
5.000
-2.500
-1.500
-0.500
0.500
1.500
2.500
3.500
4.500
DISTANCE EAST NM.

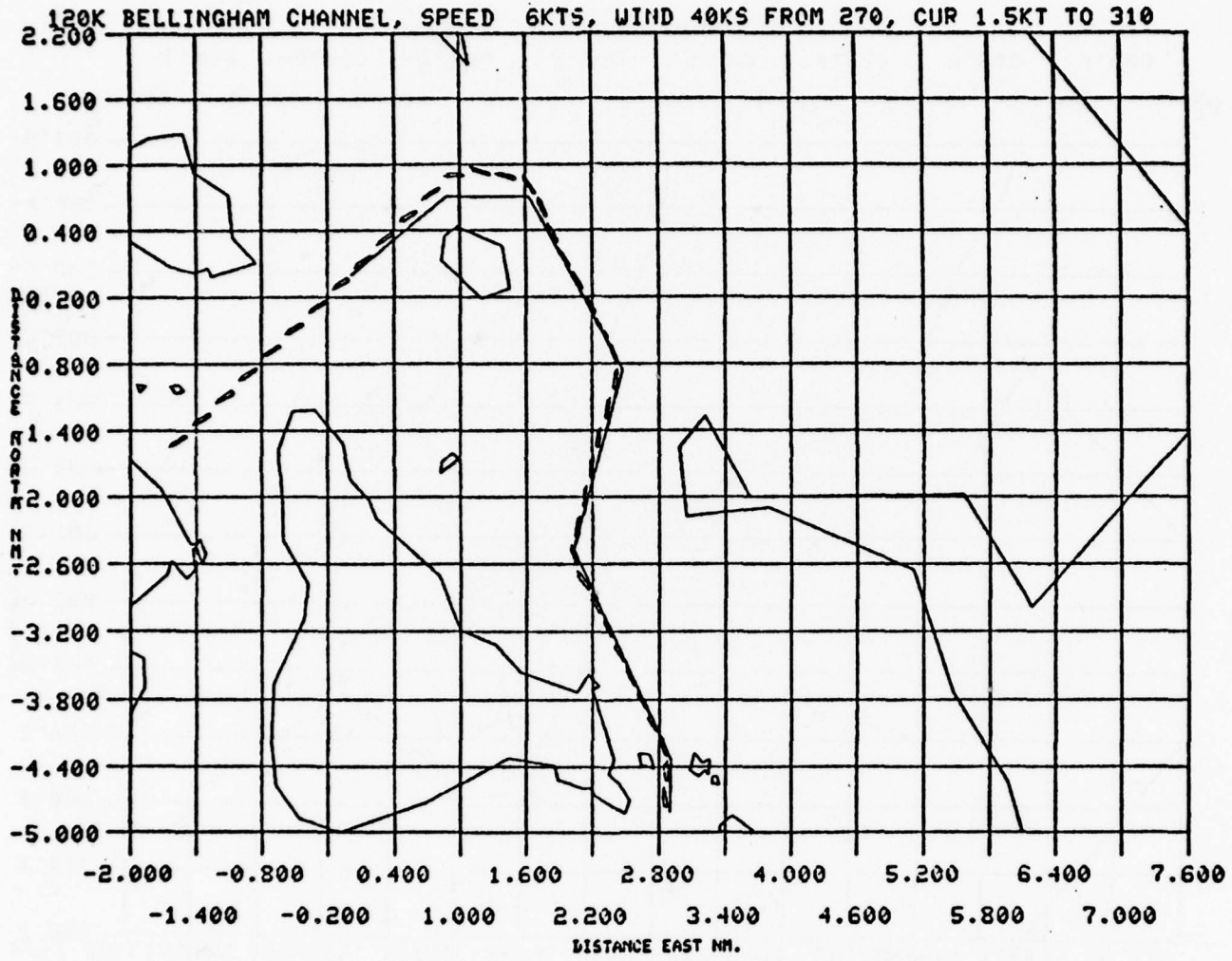

165K BELLINGHAM CHANNEL, SPEED 4KTS, WIND 40KT FROM 90,CURRENT 4.0KTS TO 45
5.000
4.500
4.000
3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
-0.500
-1.000
DISTANCE NORTH NM.
-3.000
-2.000
-1.000
0.000
1.000
2.000
3.000
4.000
5.000
-2.500
-1.500
-0.500
0.500
1.500
2.500
3.500
4.500
DISTANCE EAST NM.

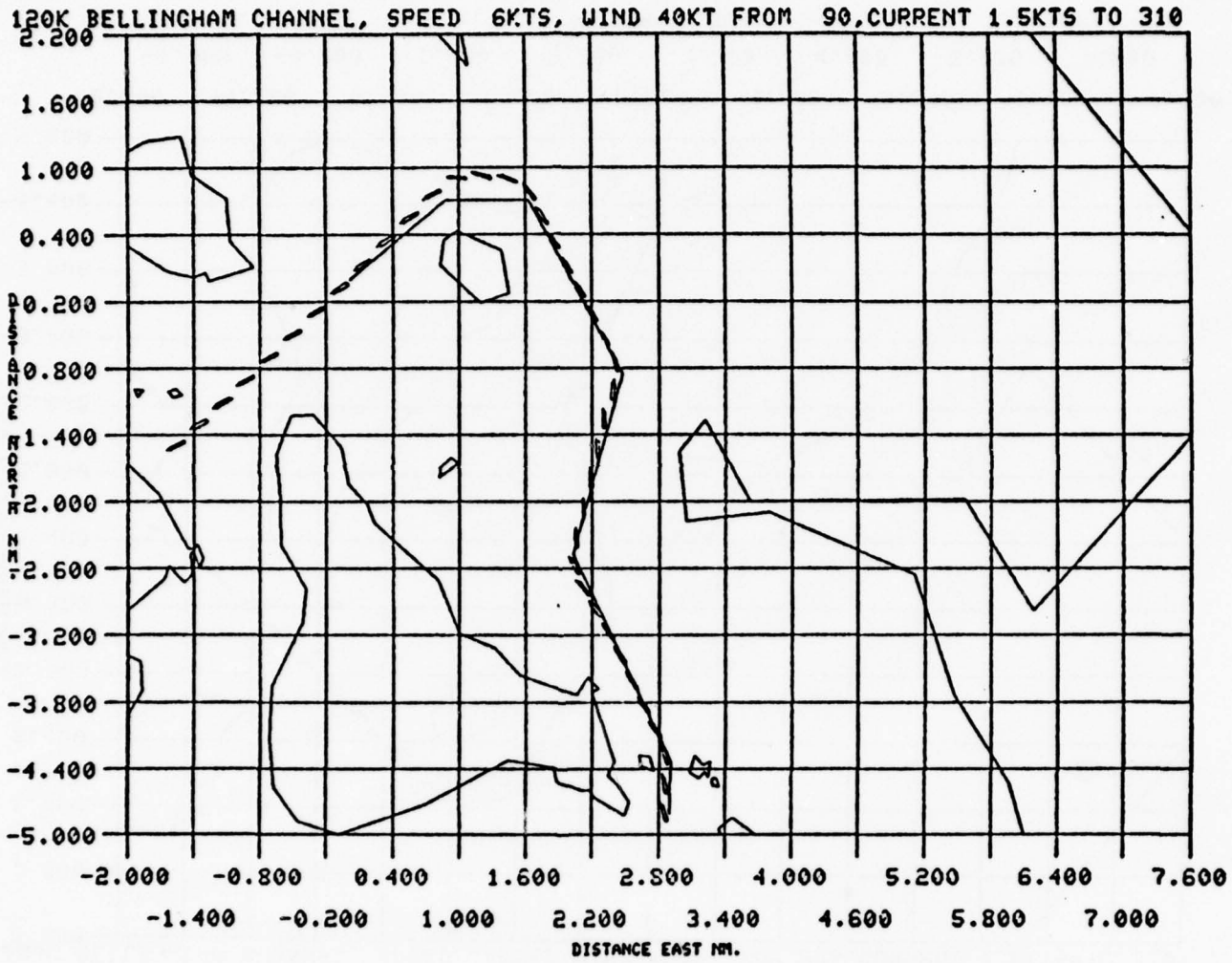

120K BELLINGHAM CHANNEL, SPEED 10KTS, WIND 40KT FROM 270,CURRENT 2.0KTS TO 240
2.200
1.600
1.000
0.400
-0.200
-0.800
-1.400
-2.000
-2.600
-3.200
-3.800
-4.400
-5.000
DISTANCE NORTH NM.
-2.000
-0.800
0.400
1.600
2.800
4.000
5.200
6.400
7.600
-1.400
-0.200
1.000
2.200
3.400
4.600
5.800
7.000
DISTANCE EAST NM.

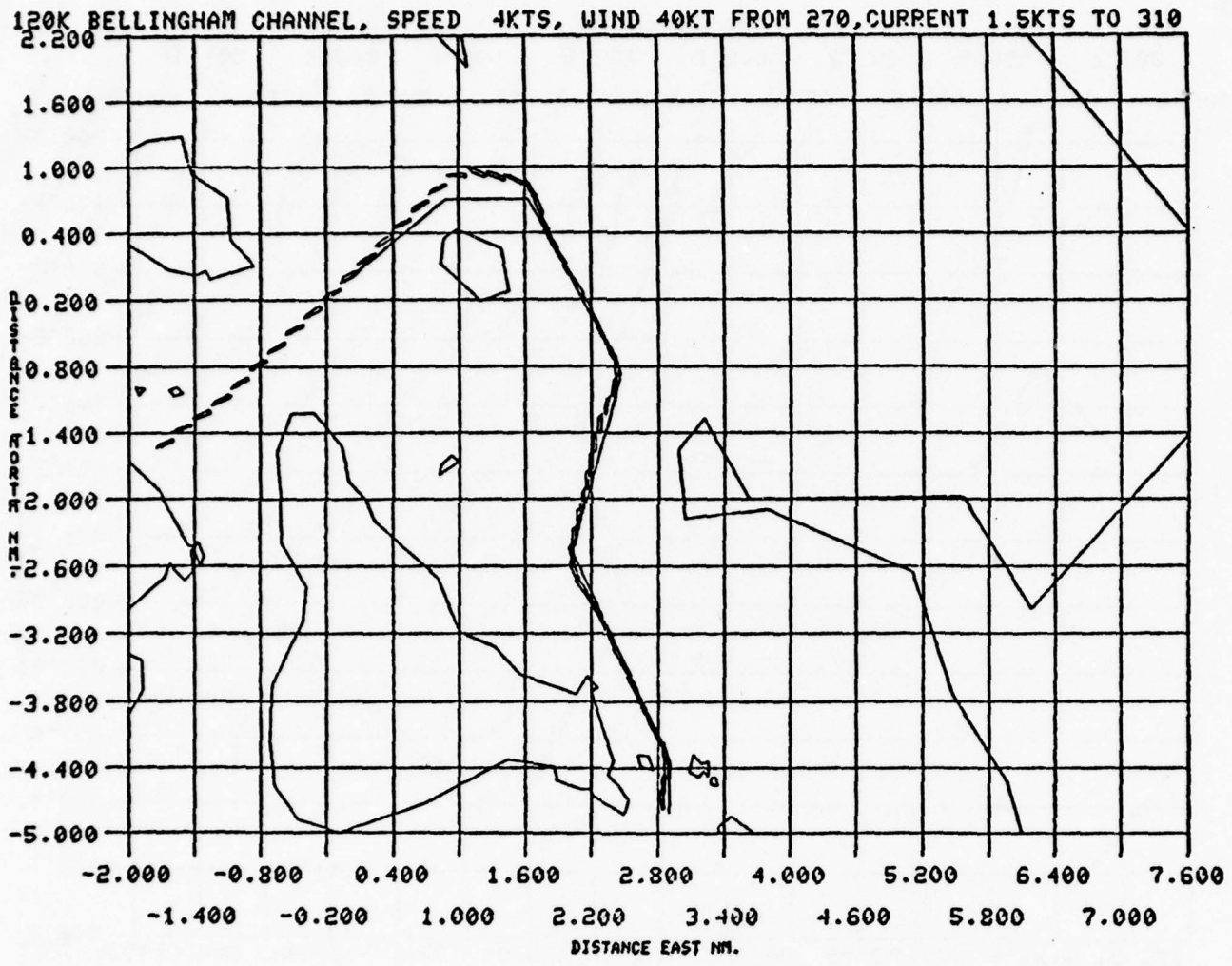

120K BELLINGHAM CHANNEL, SPEED 10KTS, WIND 40KT FROM 90,CURRENT 2.0KTS TO 240
2.200
1.600
1.000
0.400
-0.200
-0.800
-1.400
-2.000
-2.600
-3.200
-3.800
-4.400
-5.000
DISTANCE NORTH NM.
-2.000
-0.800
0.400
1.600
2.800
4.000
5.200
6.400
7.600
-1.400
-0.200
1.000
2.200
3.400
4.600
5.800
7.000
DISTANCE EAST NM.

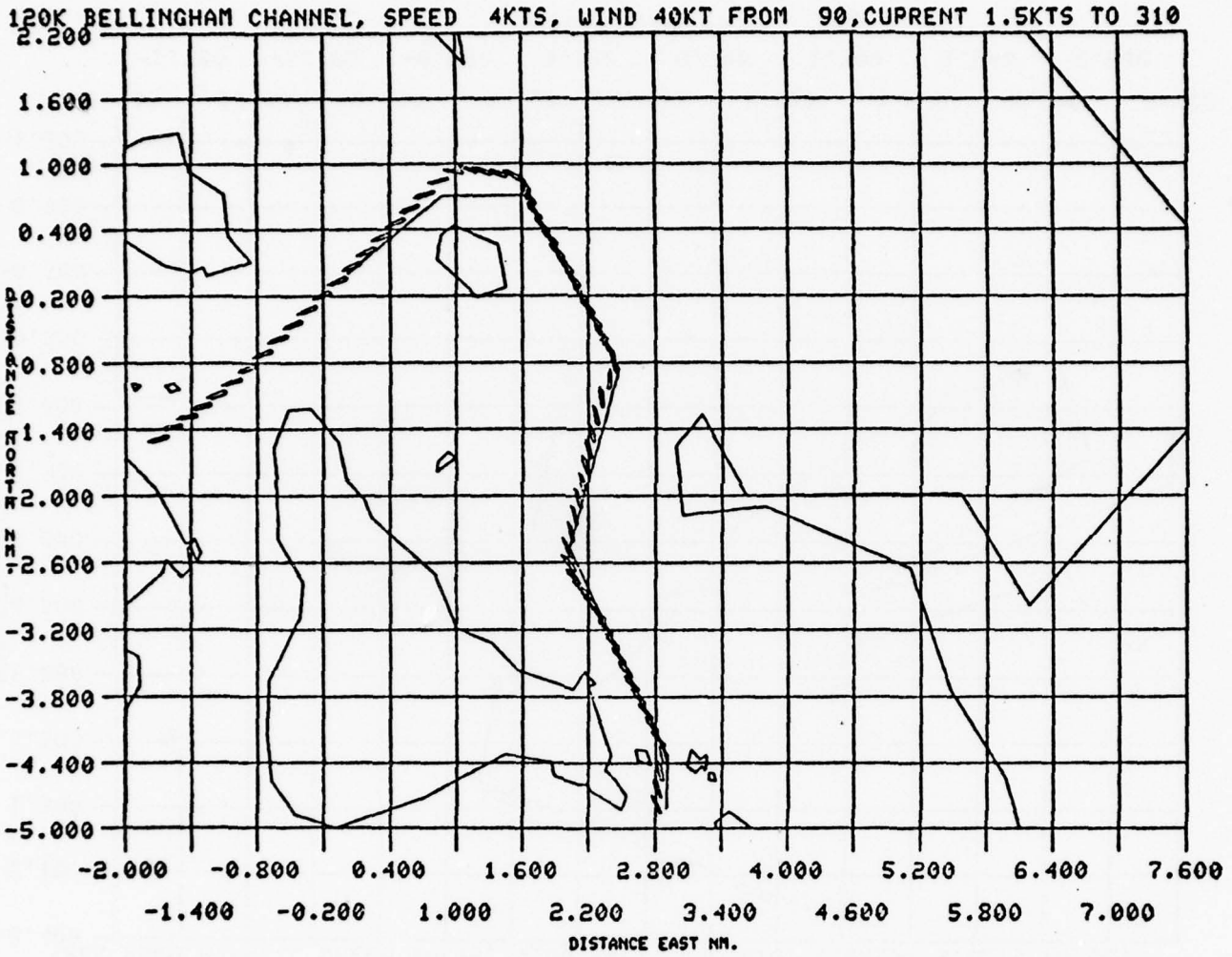

120K BELLINGHAM CHANNEL, SPEED 8KTS, WIND 40KT FROM 270,CURRENT 1.5KTS TO 310
2.200
1.600
1.000
0.400
-0.200
-0.800
-1.400
-2.000
-2.600
-3.200
-3.800
-4.400
-5.000
DISTANCE NORTH NM.
-2.000
-0.800
0.400
1.600
2.800
4.000
5.200
6.400
7.600
-1.400
-0.200
1.000
2.200
3.400
4.600
5.800
7.000
DISTANCE EAST NM.

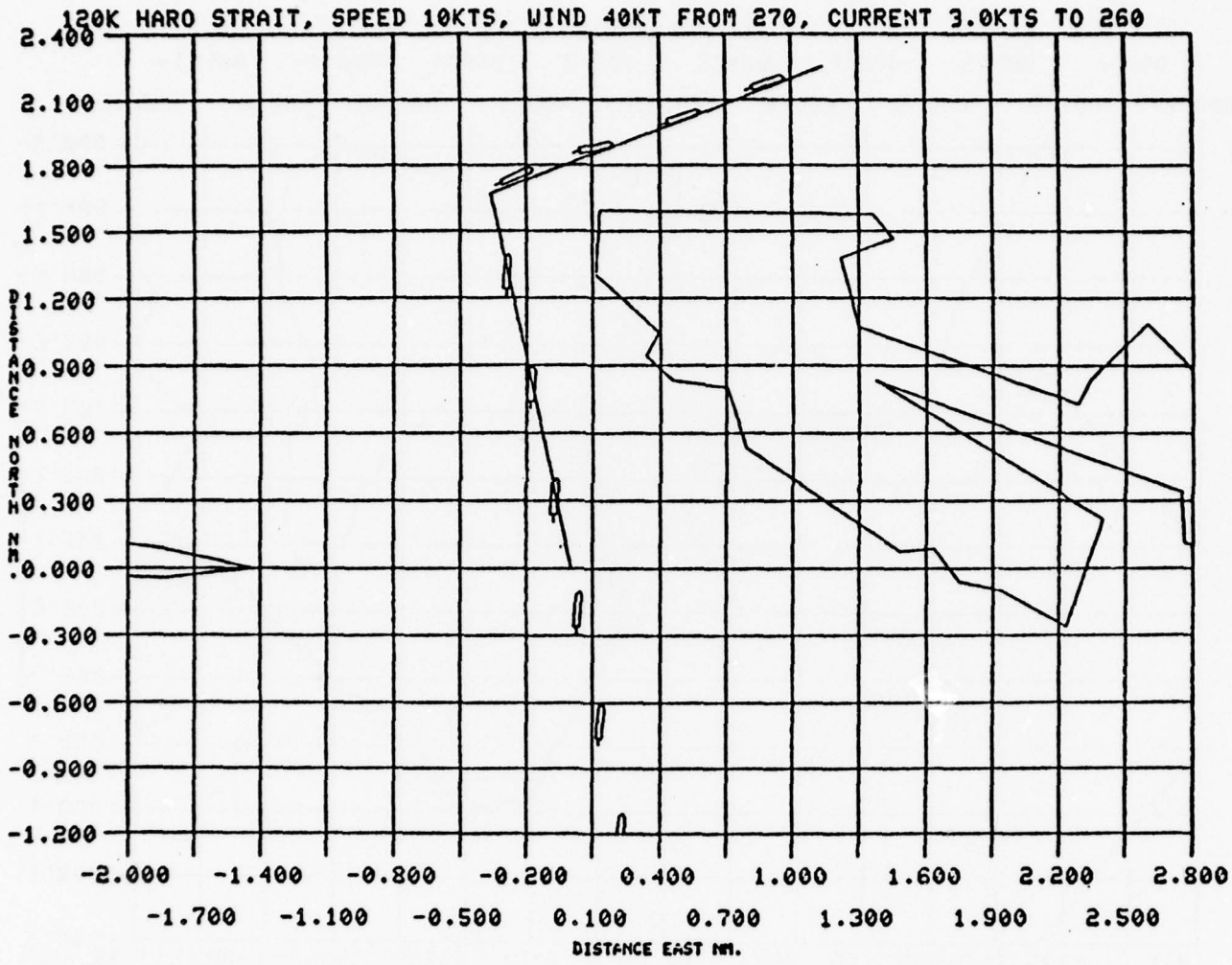

120K BELLINGHAM CHANNEL, SPEED 8KTS, WIND 40KT FROM 90,CURRENT 1.5KTS TO 310
2.200
1.600
1.000
0.400
-0.200
-0.800
-1.400
-2.000
-2.600
-3.200
-3.800
-4.400
-5.000
DISTANCE NORTH NM.
-2.000
-0.800
0.400
1.600
2.800
4.000
5.200
6.400
7.600
-1.400
-0.200
1.000
2.200
3.400
4.600
5.800
7.000
DISTANCE EAST NM.

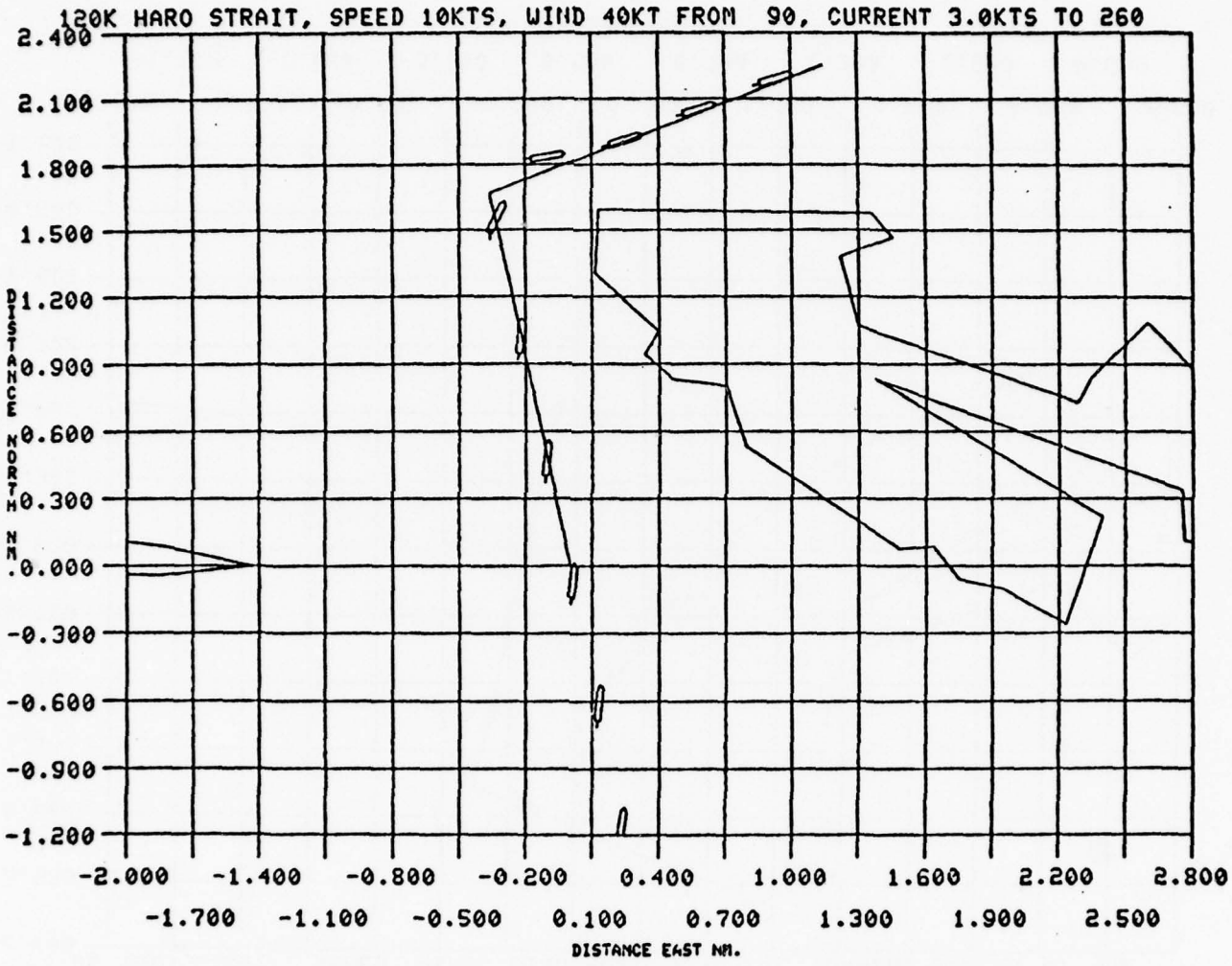

120K BELLINGHAM CHANNEL, SPEED 6KTS, WIND 40KS FROM 270, CUR 1.5KT TO 310
2.200
1.600
1.000
0.400
-0.200
-0.800
-1.400
-2.000
-2.600
-3.200
-3.800
-4.400
-5.000
DISTANCE NORTH NM.
-2.000
-0.800
0.400
1.600
2.800
4.000
5.200
6.400
7.600
-1.400
-0.200
1.000
2.200
3.400
4.600
5.800
7.000
DISTANCE EAST NM.

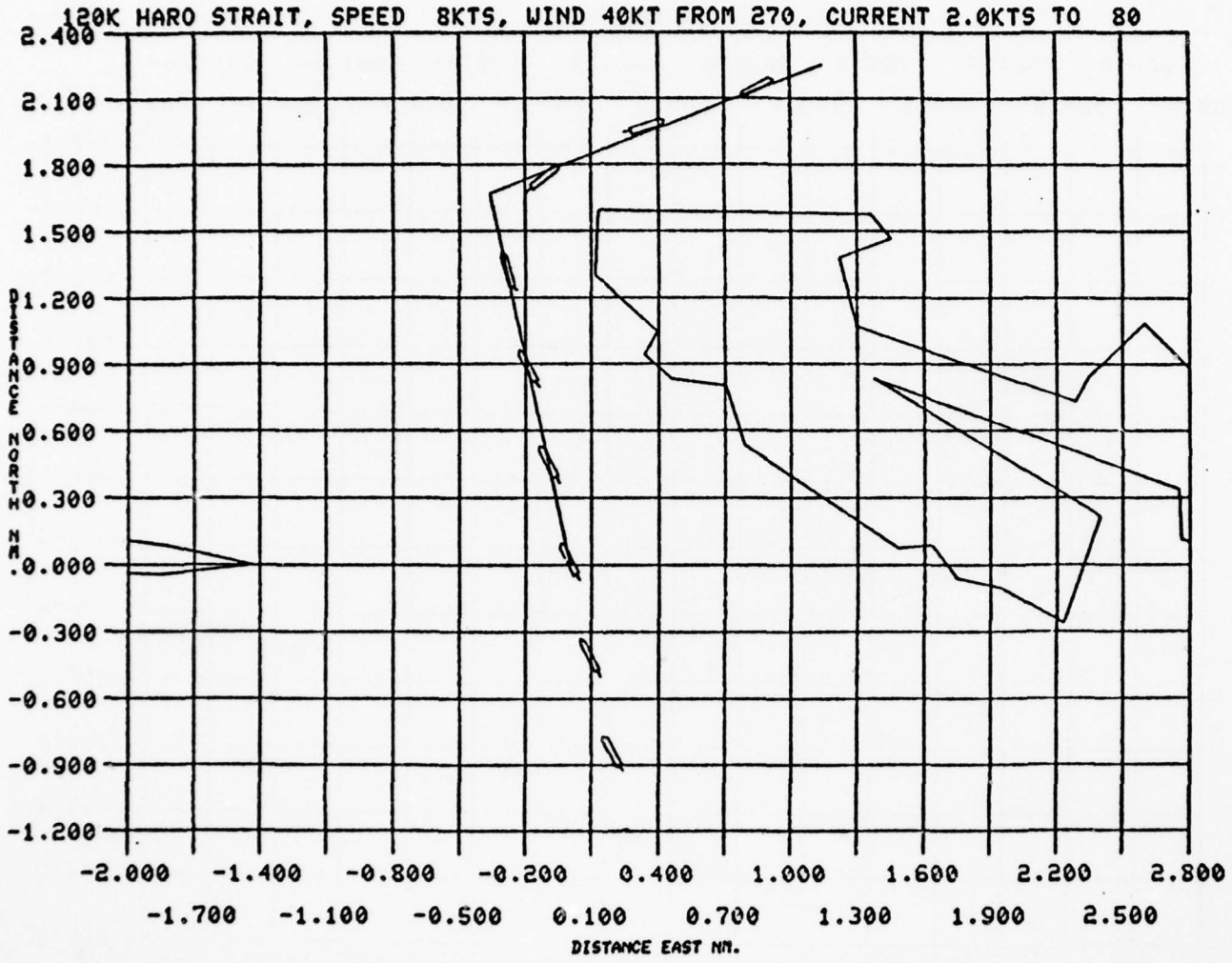

120K BELLINGHAM CHANNEL, SPEED 6KTS, WIND 40KT FROM 90,CURRENT 1.5KTS TO 310
2.200
1.600
1.000
0.400
-0.200
-0.800
-1.400
-2.000
-2.600
-3.200
-3.800
-4.400
-5.000
DISTANCE NORTH NM.
-2.000
-0.800
0.400
1.600
2.800
4.000
5.200
6.400
7.600
-1.400
-0.200
1.000
2.200
3.400
4.600
5.800
7.000
DISTANCE EAST NM.

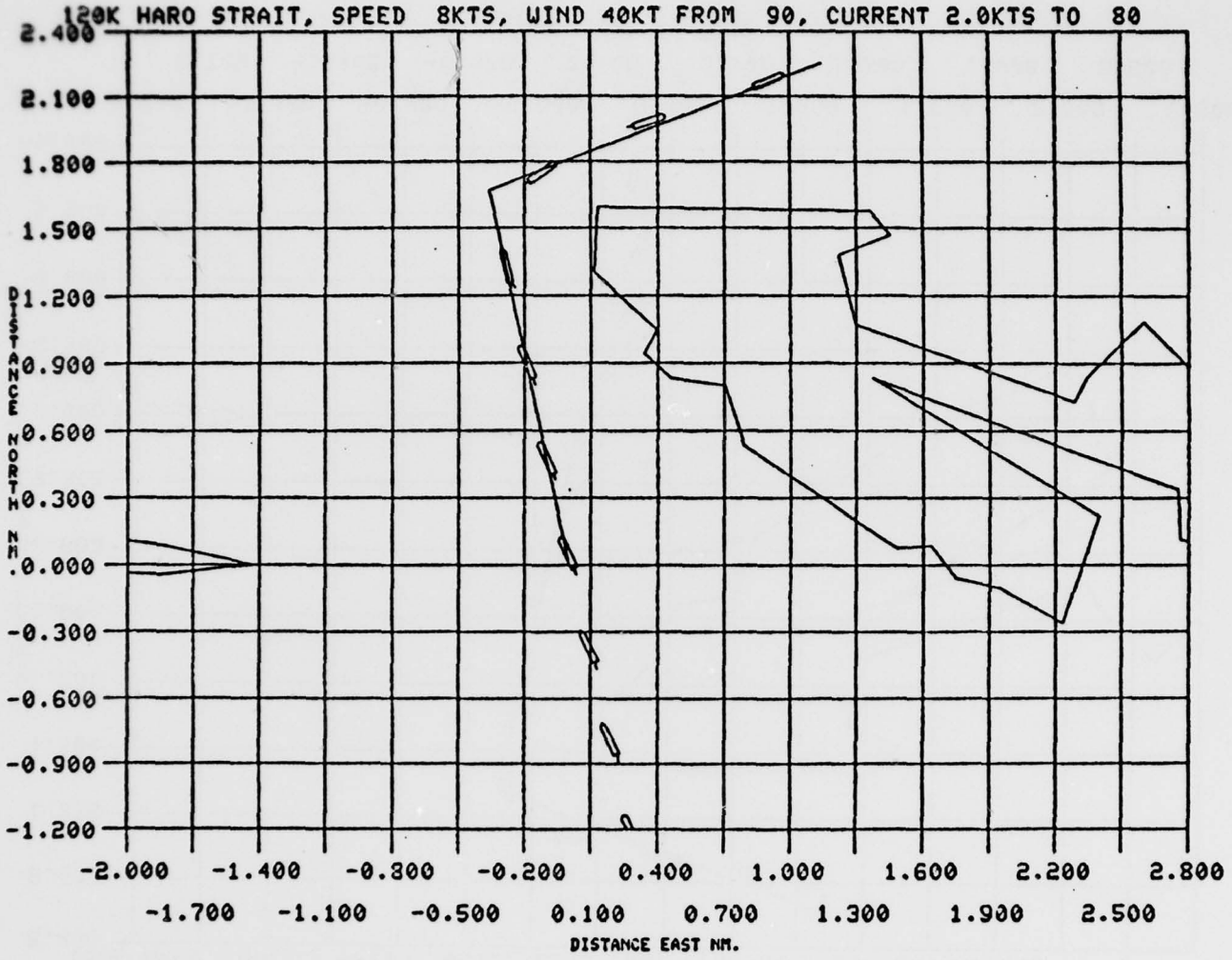

120K BELLINGHAM CHANNEL, SPEED 4KTS, WIND 40KT FROM 270,CURRENT 1.5KTS TO 310
2.200
1.600
1.000
0.400
0.200
0.800
1.400
2.000
2.600
3.200
3.800
4.400
5.000
DISTANCE NORTH NM.
-2.000
-0.800
0.400
1.600
2.800
4.000
5.200
6.400
7.600
-1.400
-0.200
1.000
2.200
3.400
4.600
5.800
7.000
DISTANCE EAST NM.

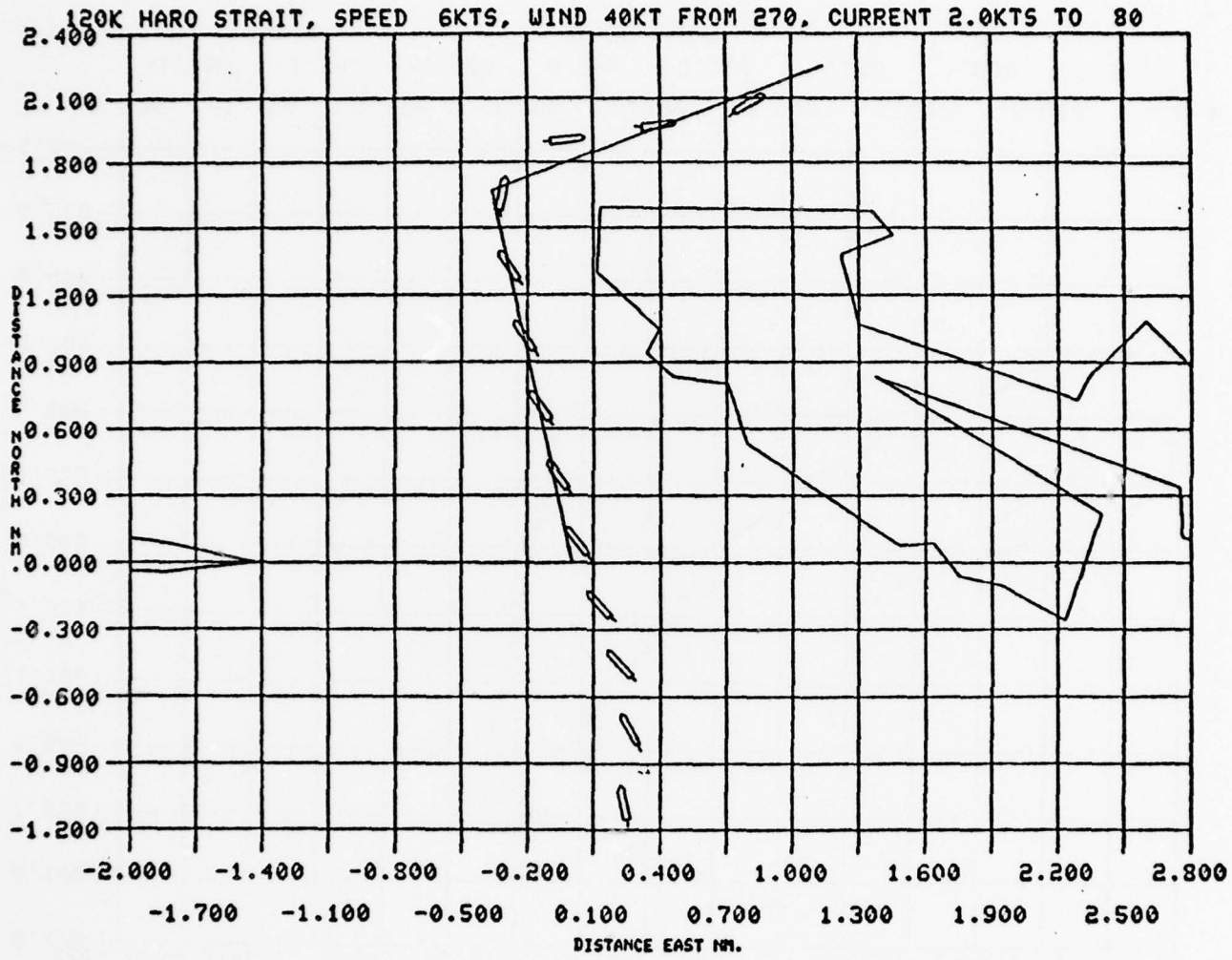

120K BELLINGHAM CHANNEL, SPEED 4KTS, WIND 40KT FROM 90,CUPRENT 1.5KTS TO 310
2.200
1.600
1.000
0.400
-0.200
-0.800
-1.400
-2.000
-2.600
-3.200
-3.800
-4.400
-5.000
DISTANCE NORTH NM.
-2.000
-0.800
0.400
1.600
2.800
4.000
5.200
6.400
7.600
-1.400
-0.200
1.000
2.200
3.400
4.600
5.800
7.000
DISTANCE EAST NM.

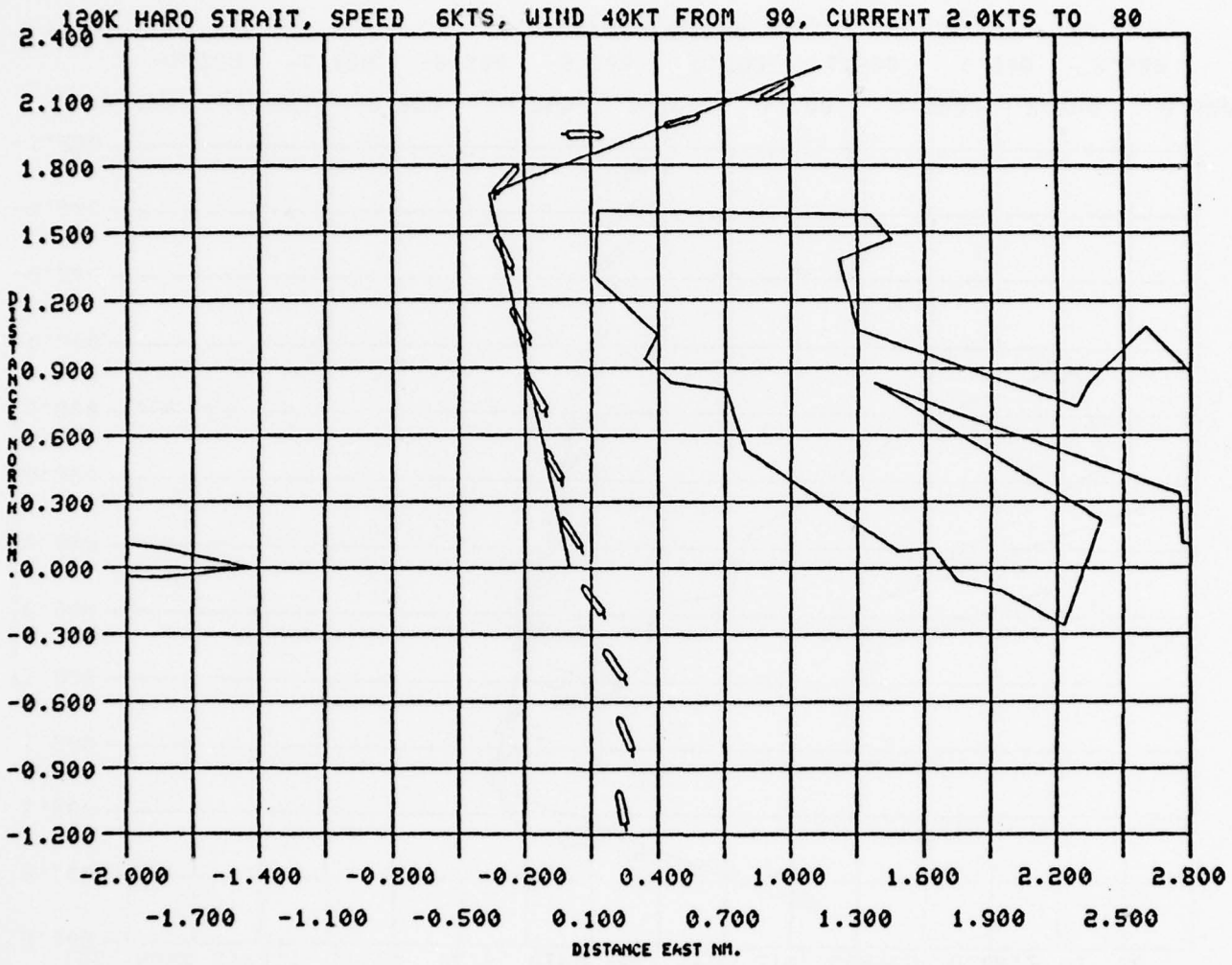

120K HARO STRAIT, SPEED 10KTS, WIND 40KT FROM 270, CURRENT 3.0KTS TO 260
2.400
2.100
1.800
1.500
1.200
0.900
0.600
0.300
0.000
-0.300
-0.600
-0.900
-1.200
DISTANCE NORTH NM.
-2.000
-1.400
-0.800
-0.200
0.400
1.000
1.600
2.200
2.800
-1.700
-1.100
-0.500
0.100
0.700
1.300
1.900
2.500
DISTANCE EAST NM.

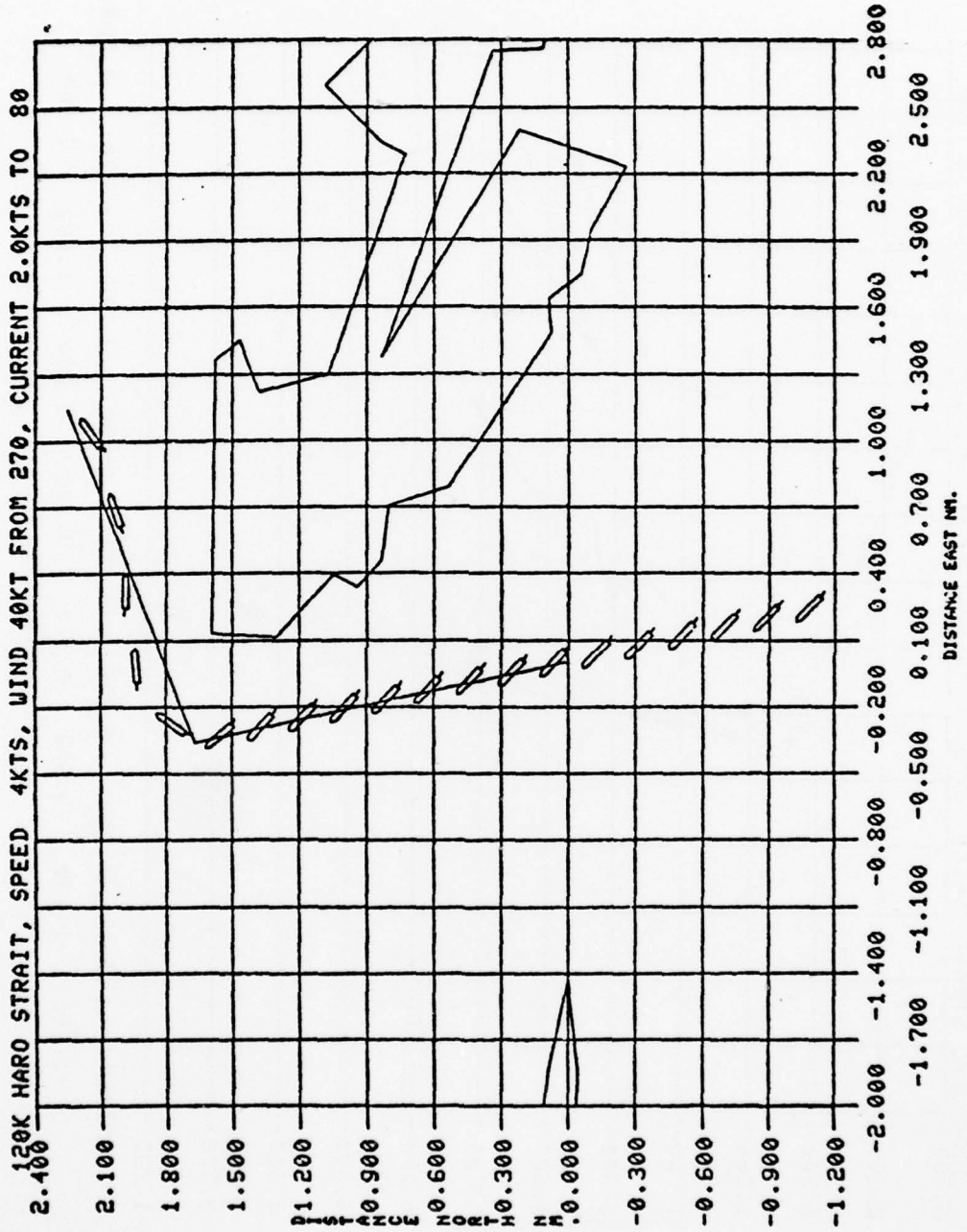

120K HARO STRAIT, SPEED 10KTS, WIND 40KT FROM 90, CURRENT 3.0KTS TO 260
2.400
2.100
1.800
1.500
1.200
0.900
0.600
0.300
0.000
-0.300
-0.600
-0.900
-1.200
DISTANCE NORTH NM.
-2.000
-1.400
-0.800
-0.200
0.400
1.000
1.600
2.200
2.800
-1.700
-1.100
-0.500
0.100
0.700
1.300
1.900
2.500
DISTANCE EAST NM.

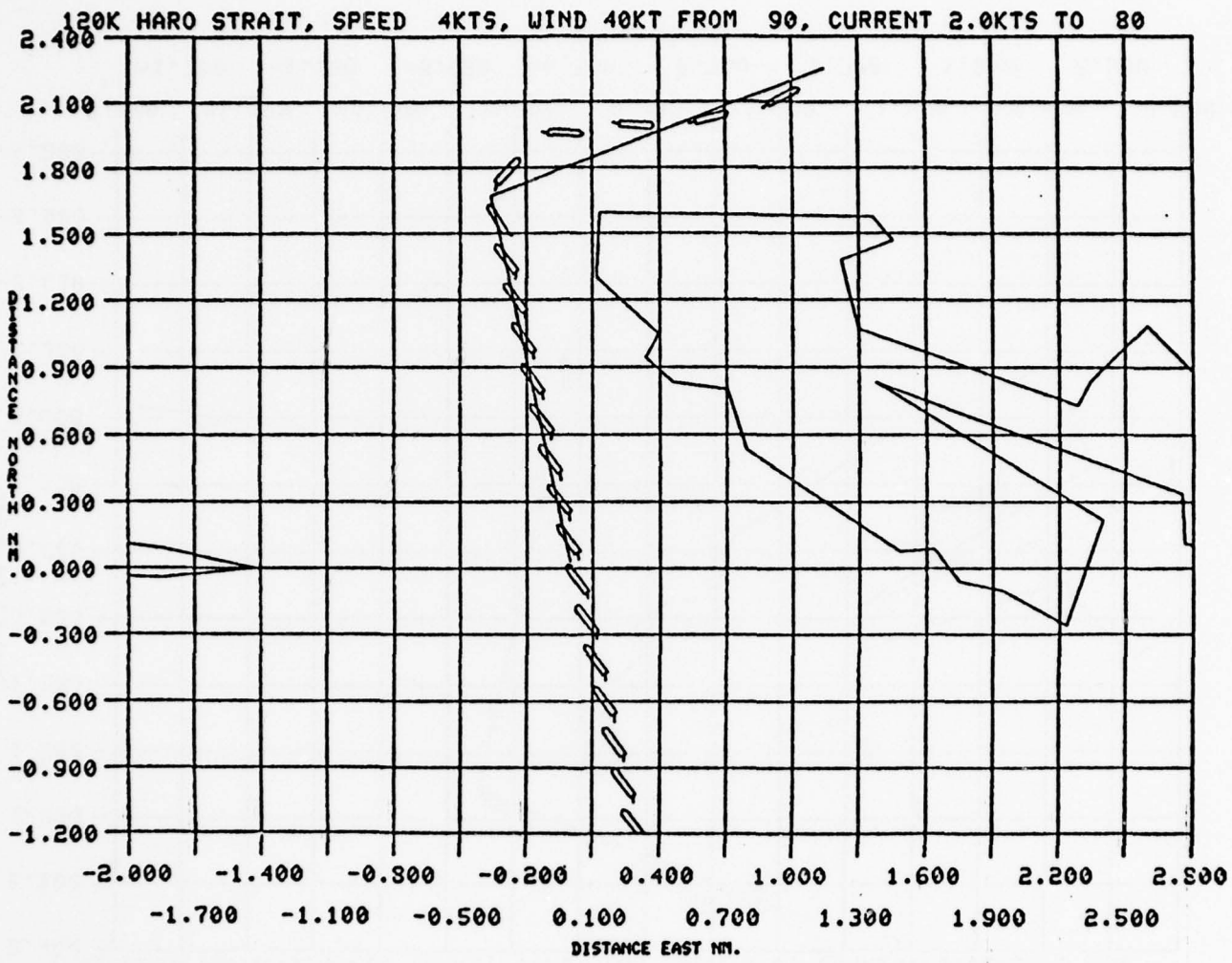

120K HARO STRAIT, SPEED 8KTS, WIND 40KT FROM 270, CURRENT 2.0KTS TO 80
2.400
2.100
1.800
1.500
1.200
0.900
0.600
0.300
0.000
-0.300
-0.600
-0.900
-1.200
DISTANCE NORTH NM.
-2.000
-1.400
-0.800
-0.200
0.400
1.000
1.600
2.200
2.800
-1.700
-1.100
-0.500
0.100
0.700
1.300
1.900
2.500
DISTANCE EAST NM.

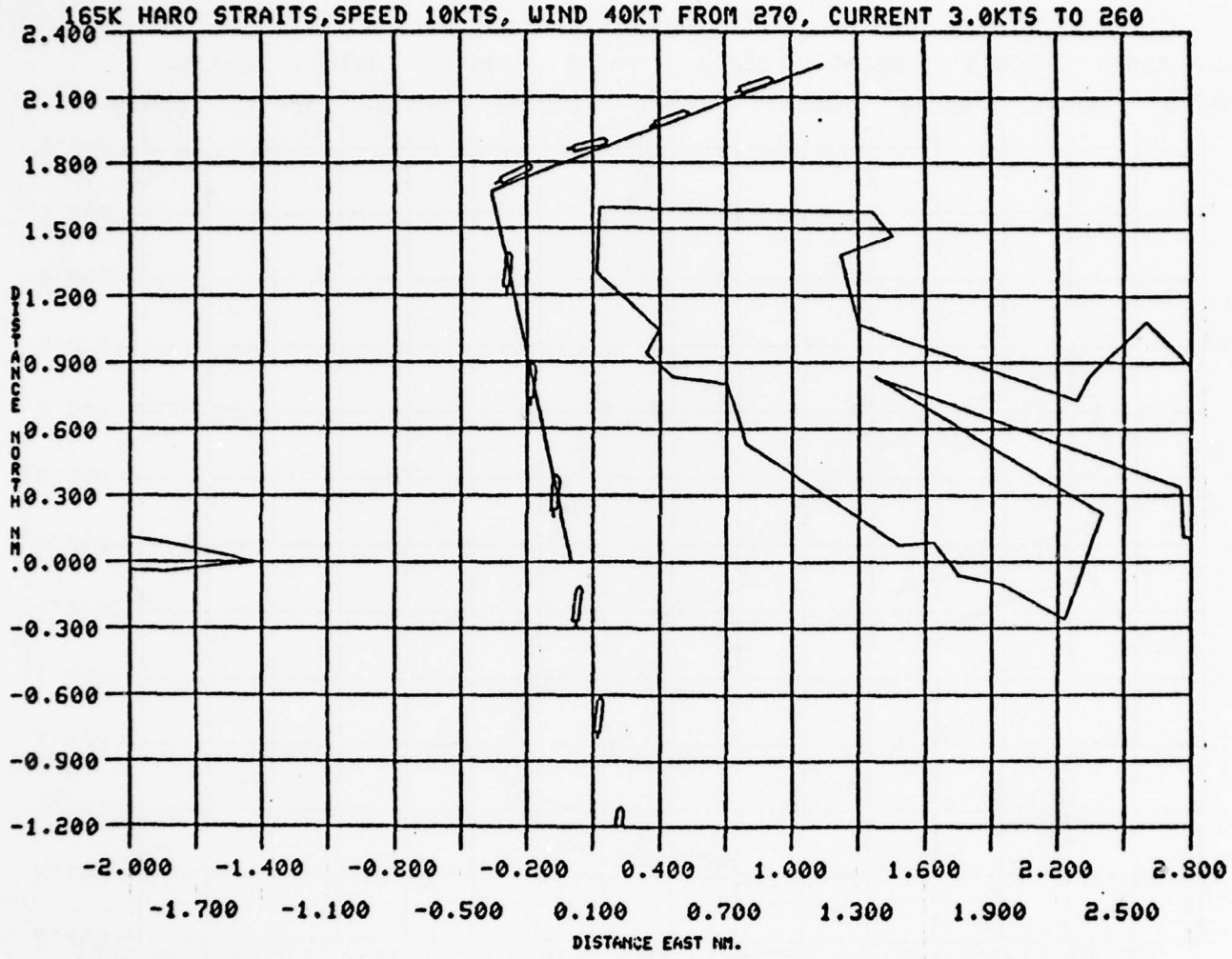

120K HARO STRAIT, SPEED 8KTS, WIND 40KT FROM 90, CURRENT 2.0KTS TO 80
2.400
2.100
1.800
1.500
1.200
0.900
0.600
0.300
0.000
-0.300
-0.600
-0.900
-1.200
DISTANCE NORTH NM.
-2.000
-1.400
-0.800
-0.200
0.400
1.000
1.600
2.200
2.800
-1.700
-1.100
-0.500
0.100
0.700
1.300
1.900
2.500
DISTANCE EAST NM.

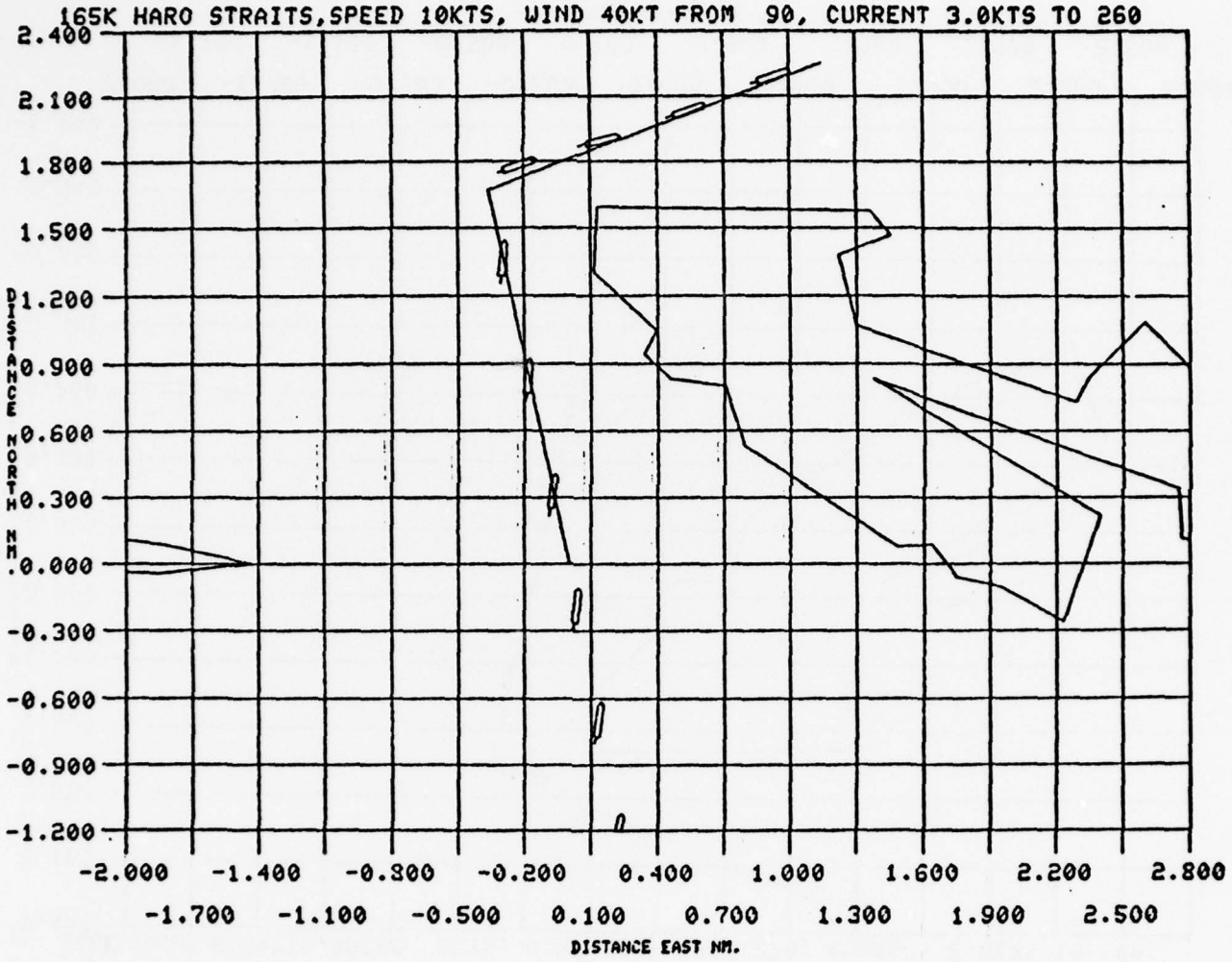

120K HARO STRAIT, SPEED 6KTS, WIND 40KT FROM 270, CURRENT 2.0KTS TO 80
2.400
2.100
1.800
1.500
1.200
0.900
0.600
0.300
0.000
-0.300
-0.600
-0.900
-1.200
DISTANCE NORTH NM.
-2.000
-1.400
-0.800
-0.200
0.400
1.000
1.600
2.200
2.800
-1.700
-1.100
-0.500
0.100
0.700
1.300
1.900
2.500
DISTANCE EAST NM.

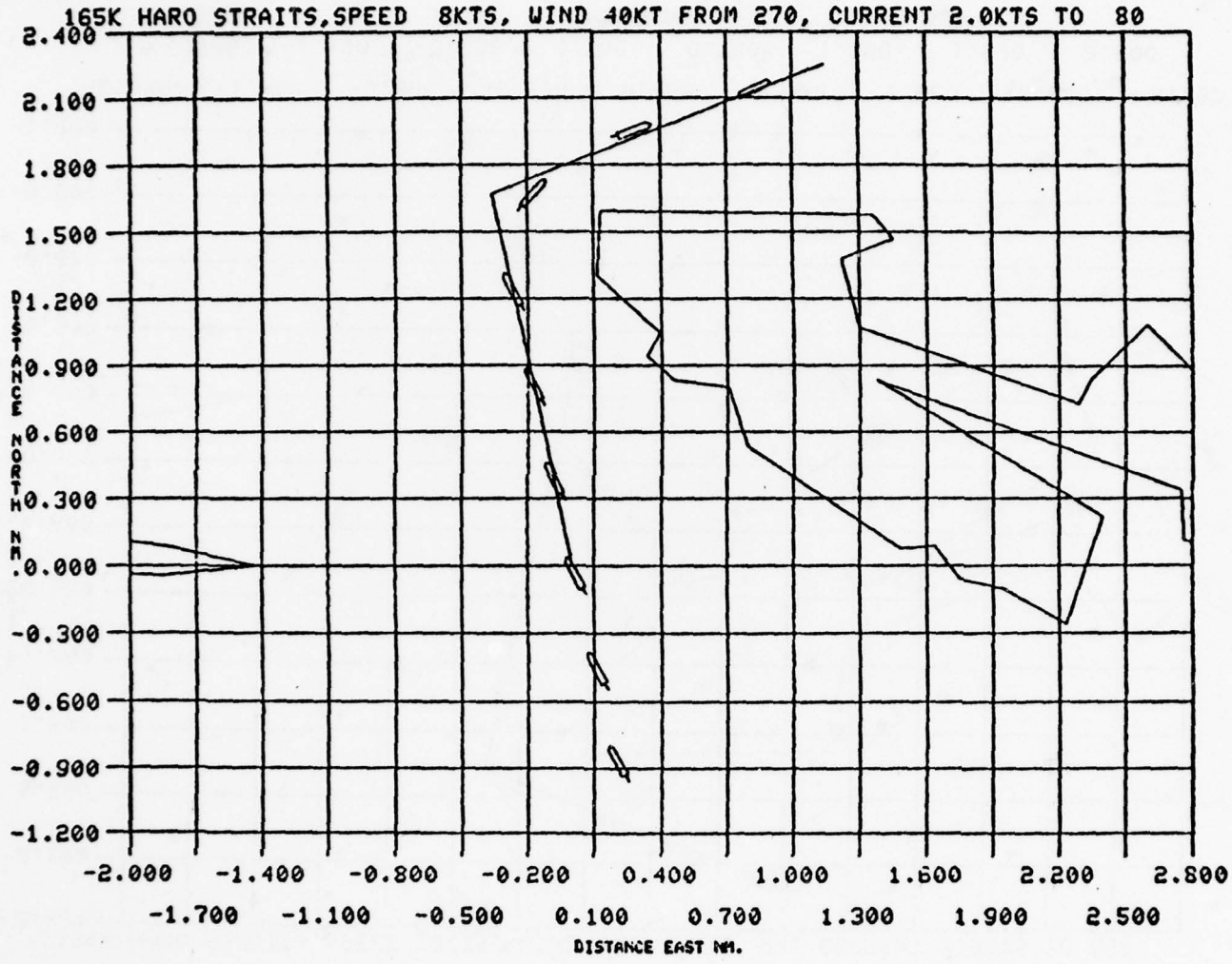

120K HARO STRAIT, SPEED 6KTS, WIND 40KT FROM 90, CURRENT 2.0KTS TO 80
2.400
2.100
1.800
1.500
1.200
0.900
0.600
0.300
0.000
-0.300
-0.600
-0.900
-1.200
DISTANCE NORTH NM.
-2.000
-1.400
-0.800
-0.200
0.400
1.000
1.600
2.200
2.800
-1.700
-1.100
-0.500
0.100
0.700
1.300
1.900
2.500
DISTANCE EAST NM.

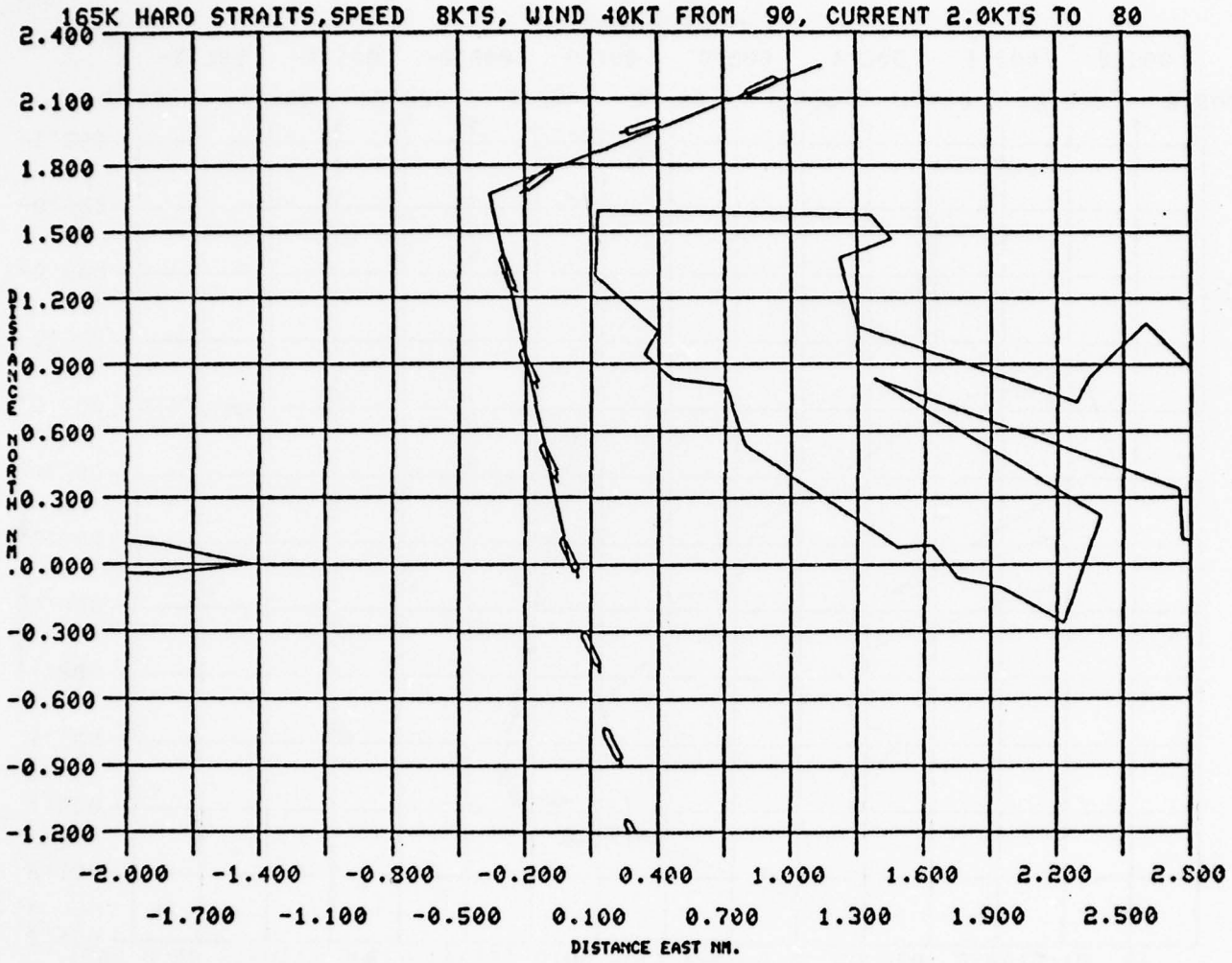

120K HARO STRAIT, SPEED 4KTS, WIND 40KT FROM 270, CURRENT 2.0KTS TO 80
2.400
2.100
1.800
1.500
1.200
0.900
0.600
0.300
0.000
-0.300
-0.600
-0.900
-1.200
DISTANCE NORTH NM.
-2.000
-1.700
-1.400
-1.100
-0.800
-0.500
-0.200
0.100
0.400
0.700
1.000
1.300
1.600
1.900
2.200
2.500
2.800
DISTANCE EAST NM.

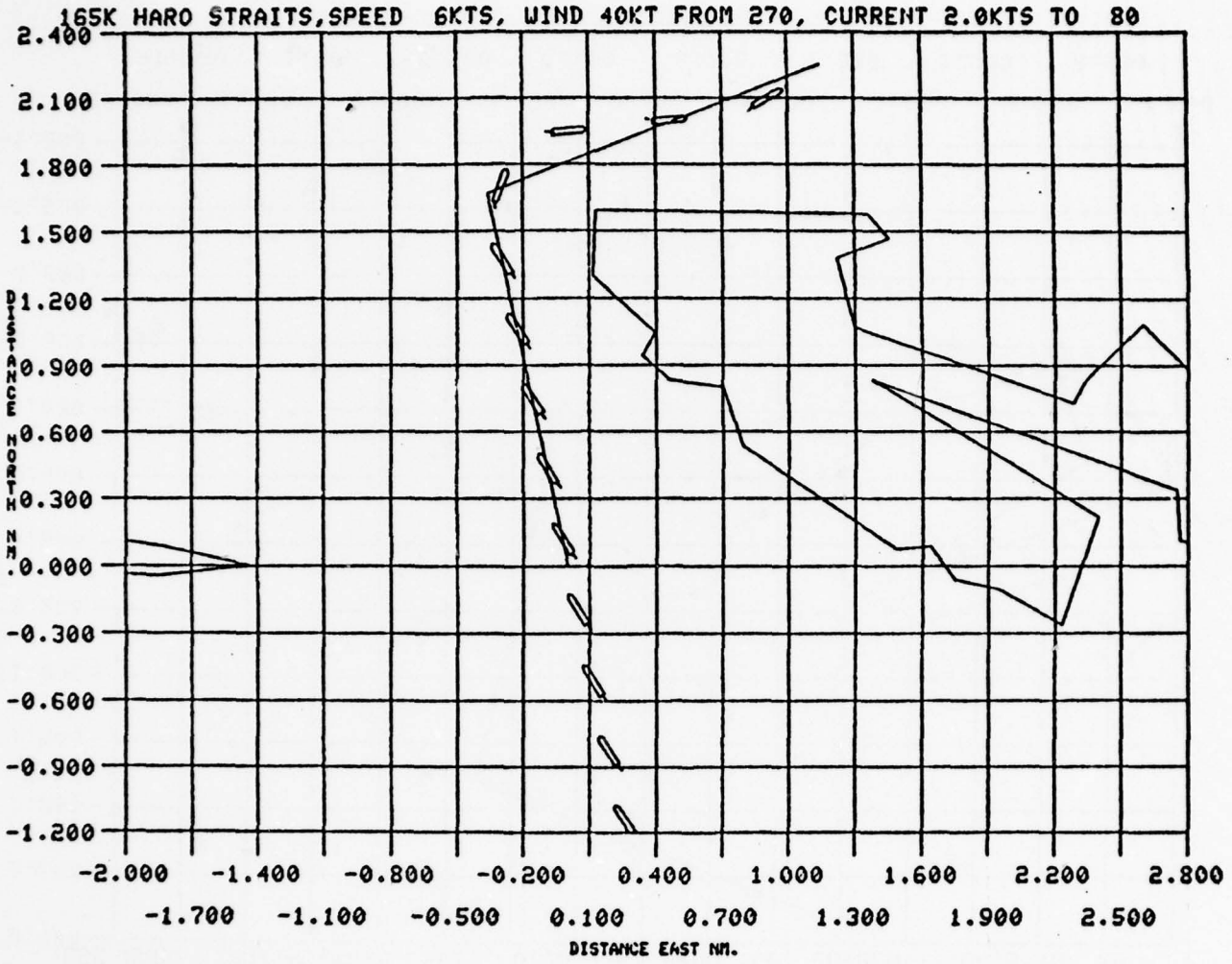

120K HARO STRAIT, SPEED 4KTS, WIND 40KT FROM 90, CURRENT 2.0KTS TO 80
2.400
2.100
1.800
1.500
1.200
0.900
0.600
0.300
0.000
-0.300
-0.600
-0.900
-1.200
DISTANCE NORTH NM.
-2.000
-1.400
-0.800
-0.200
0.400
1.000
1.600
2.200
2.800
-1.700
-1.100
-0.500
0.100
0.700
1.300
1.900
2.500
DISTANCE EAST NM.

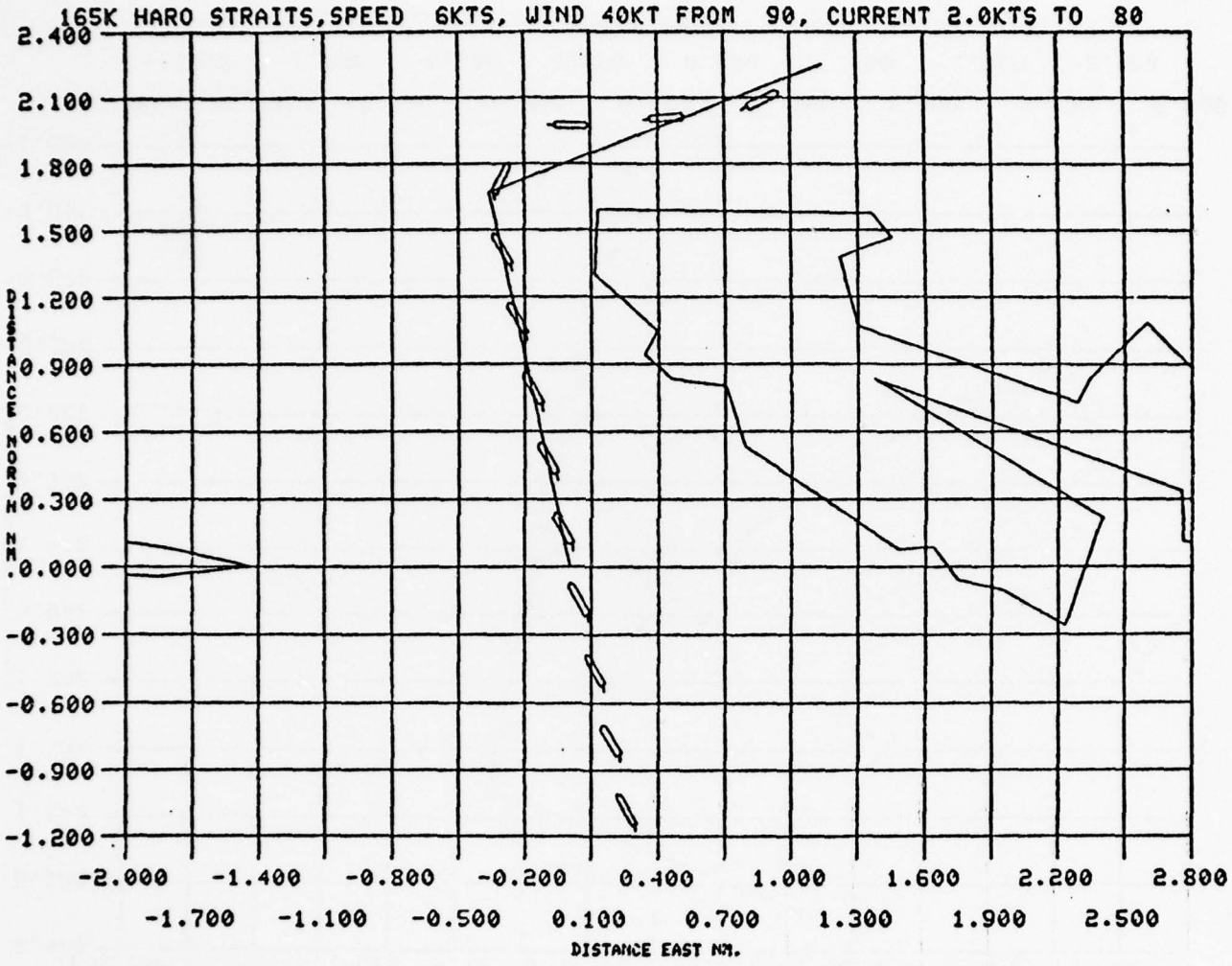

165K HARO STRAITS,SPEED 10KTS, WIND 40KT FROM 270, CURRENT 3.0KTS TO 260
2.400
2.100
1.800
1.500
1.200
0.900
0.600
0.300
0.000
-0.300
-0.600
-0.900
-1.200
DISTANCE NORTH NM.
-2.000
-1.400
-0.800
-0.200
0.400
1.000
1.600
2.200
2.800
-1.700
-1.100
-0.500
0.100
0.700
1.300
1.900
2.500
DISTANCE EAST NM.

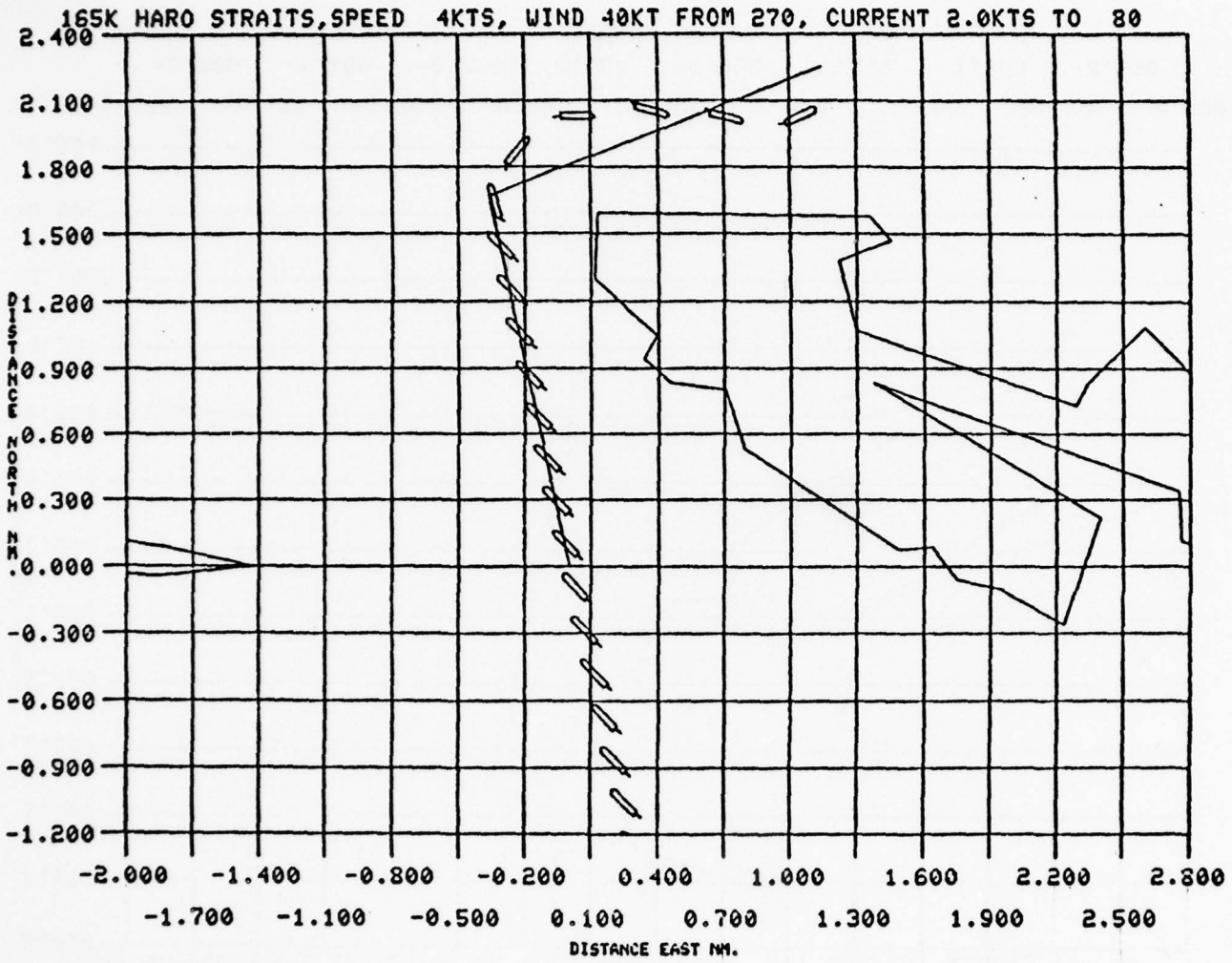

165K HARO STRAITS,SPEED 10KTS, WIND 40KT FROM 90, CURRENT 3.0KTS TO 260
2.400
2.100
1.800
1.500
1.200
0.900
0.600
0.300
.0.000
-0.300
-0.600
-0.900
-1.200
DISTANCE NORTH NM.
-2.000 -1.400 -0.800 -0.200 0.400 1.000 1.600 2.200 2.800
-1.700 -1.100 -0.500 0.100 0.700 1.300 1.900 2.500
DISTANCE EAST NM.

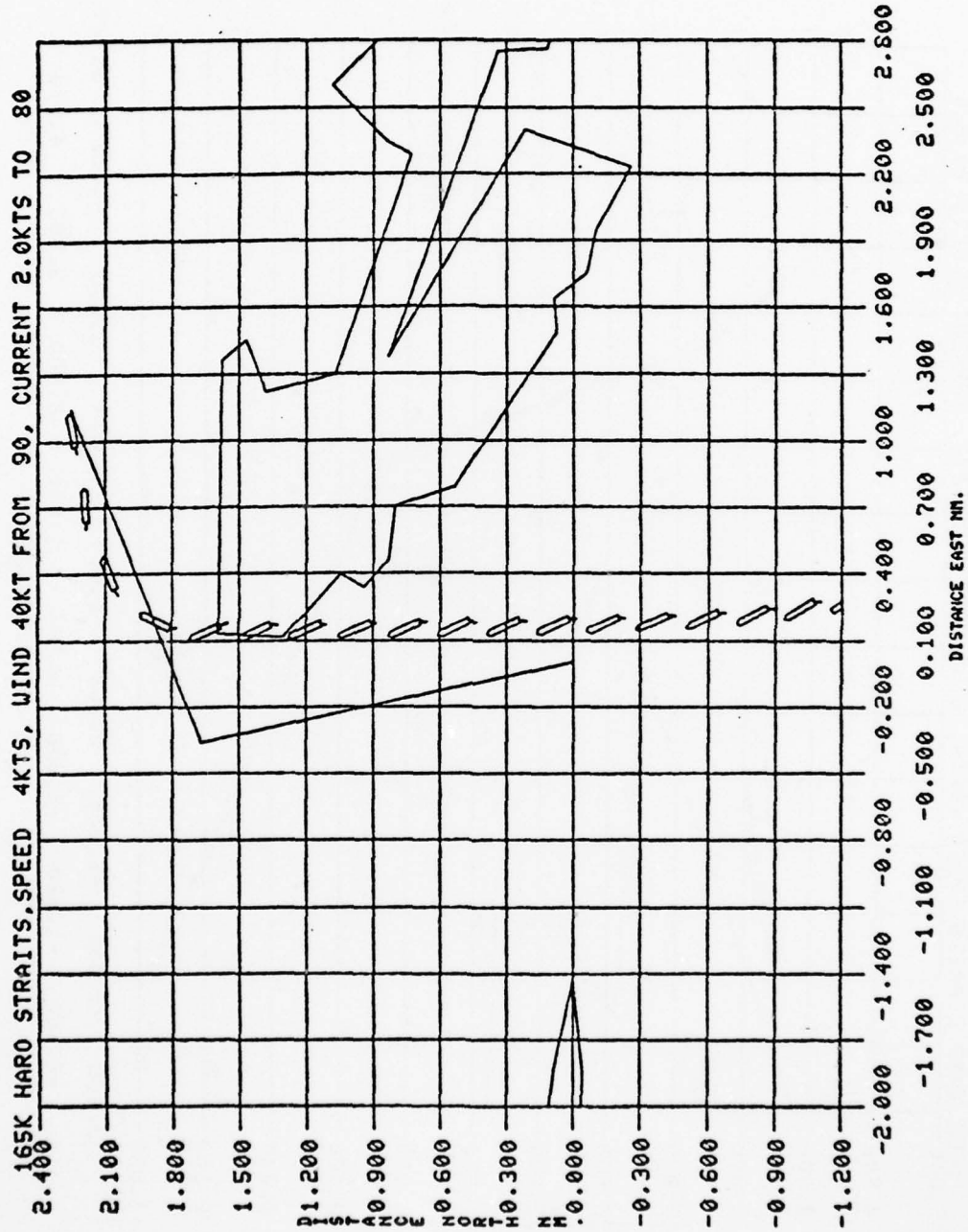

165K HARO STRAITS,SPEED 8KTS, WIND 40KT FROM 270, CURRENT 2.0KTS TO 80
2.400
2.100
1.800
1.500
1.200
0.900
0.600
0.300
0.000
-0.300
-0.600
-0.900
-1.200
DISTANCE NORTH NM.
-2.000
-1.400
-0.800
-0.200
0.400
1.000
1.600
2.200
2.800
-1.700
-1.100
-0.500
0.100
0.700
1.300
1.900
2.500
DISTANCE EAST NM.

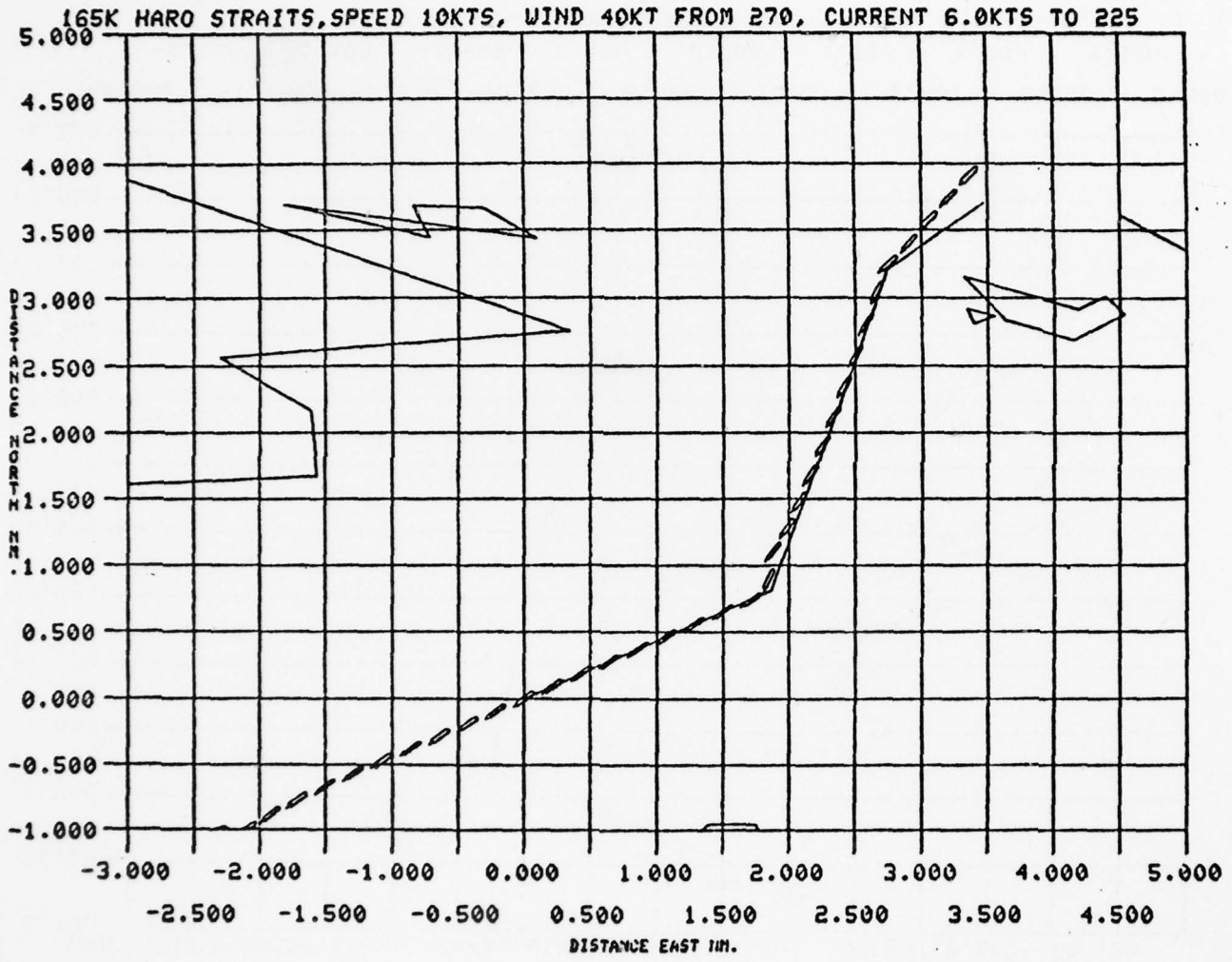

165K HARO STRAITS,SPEED 8KTS, WIND 40KT FROM 90, CURRENT 2.0KTS TO 80
2.400
2.100
1.800
1.500
1.200
0.900
0.600
0.300
0.000
-0.300
-0.600
-0.900
-1.200
DISTANCE NORTH NM.
-2.000
-1.400
-0.800
-0.200
0.400
1.000
1.600
2.200
2.800
-1.700
-1.100
-0.500
0.100
0.700
1.300
1.900
2.500
DISTANCE EAST NM.


165K HARO STRAITS,SPEED 6KTS, WIND 40KT FROM 270, CURRENT 2.0KTS TO 80
2.400
2.100
1.800
1.500
1.200
0.900
0.600
0.300
0.000
-0.300
-0.600
-0.900
-1.200
DISTANCE NORTH NM.
-2.000
-1.400
-0.800
-0.200
0.400
1.000
1.600
2.200
2.800
-1.700
-1.100
-0.500
0.100
0.700
1.300
1.900
2.500
DISTANCE EAST NM.


165K HARO STRAITS,SPEED 6KTS, WIND 40KT FROM 90, CURRENT 2.0KTS TO 80
2.400
2.100
1.800
1.500
1.200
0.900
0.600
0.300
0.000
-0.300
-0.600
-0.900
-1.200
DISTANCE NORTH NM.
-2.000
-1.400
-0.800
-0.200
0.400
1.000
1.600
2.200
2.800
-1.700
-1.100
-0.500
0.100
0.700
1.300
1.900
2.500
DISTANCE EAST NM.

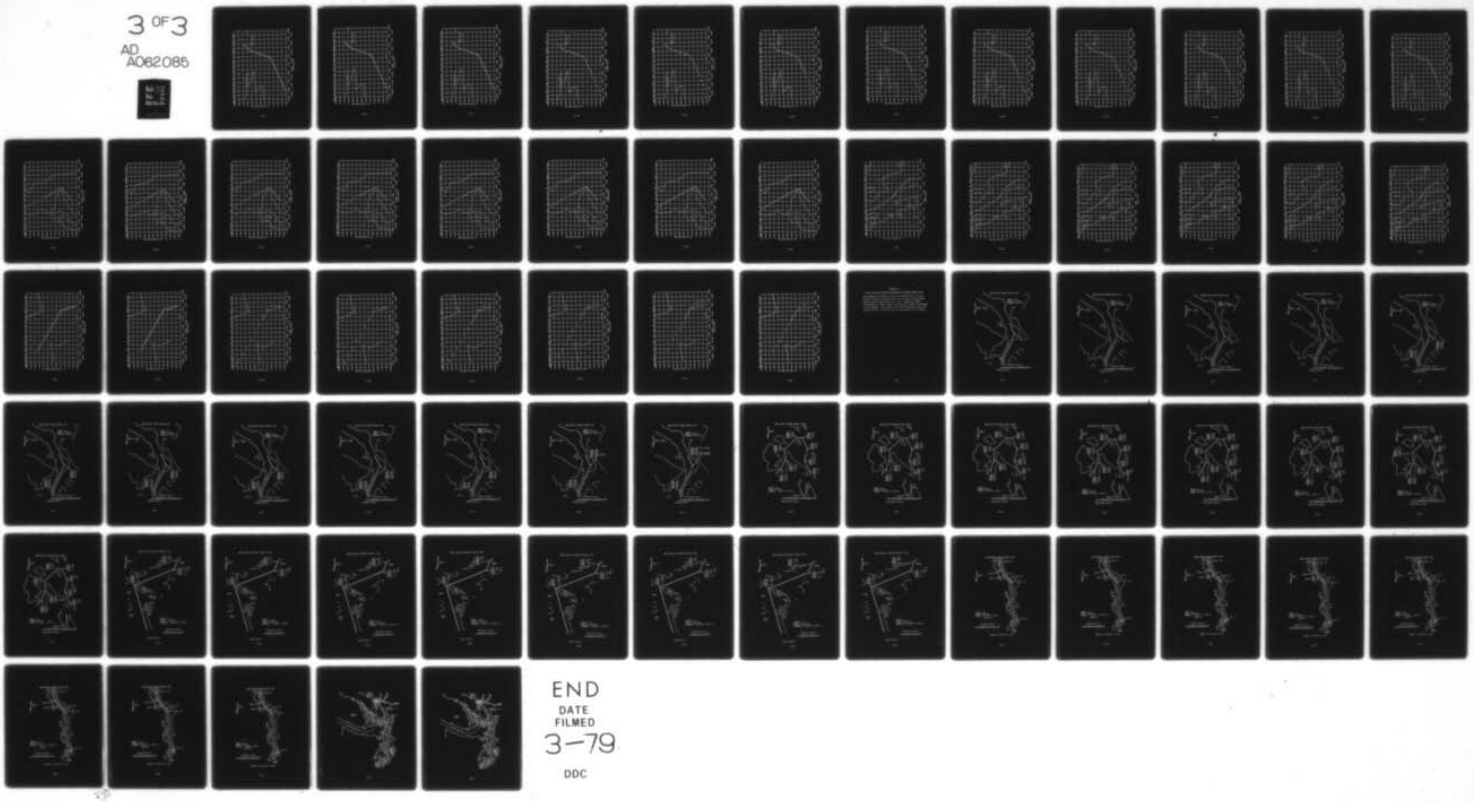

165K HARO STRAITS,SPEED 4KTS, WIND 10KT FROM 270, CURRENT 2.0KTS TO 80
2.400
2.100
1.800
1.500
1.200
0.900
0.600
0.300
0.000
-0.300
-0.600
-0.900
-1.200
DISTANCE NORTH NM.
-2.000
-1.400
-0.800
-0.200
0.400
1.000
1.600
2.200
2.800
-1.700
-1.100
-0.500
0.100
0.700
1.300
1.900
2.500
DISTANCE EAST NM.


165K HARO STRAITS,SPEED 4KTS, WIND 40KT FROM 90, CURRENT 2.0KTS TO 80
2.400
2.100
1.800
1.500
1.200
0.900
0.600
0.300
0.000
-0.300
-0.600
-0.900
-1.200
DISTANCE NORTH IN NM.
-2.000
-1.700
-1.400
-1.100
-0.800
-0.500
-0.200
0.100
0.400
0.700
1.000
1.300
1.600
1.900
2.200
2.500
2.800
DISTANCE EAST NM.


165K HARO STRAITS,SPEED 10KTS, WIND 40KT FROM 270, CURRENT 6.0KTS TO 225
5.000
4.500
4.000
3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
-0.500
-1.000
DISTANCE NORTH NM.
-3.000
-2.000
-1.000
0.000
1.000
2.000
3.000
4.000
5.000
-2.500
-1.500
-0.500
0.500
1.500
2.500
3.500
4.500
DISTANCE EAST NM.

AD-A062 085 NATIONAL MARITIME RESEARCH CENTER KINGS POINT NY F/G 13/10
AN INVESTIGATION INTO SAFETY OF PASSAGE OF LARGE TANKERS IN THE--ETC(U)
OCT 78 J RIEK, S TENENBAUM, W MCILROY MIPR-Z70099-8-843822
UNCLASSIFIED USCG-D-79-78-APP-2 NL

3 OF 3
AD A062086



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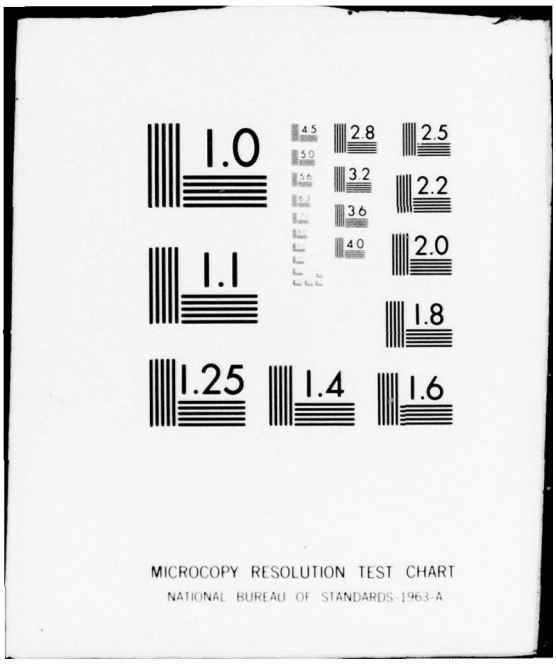
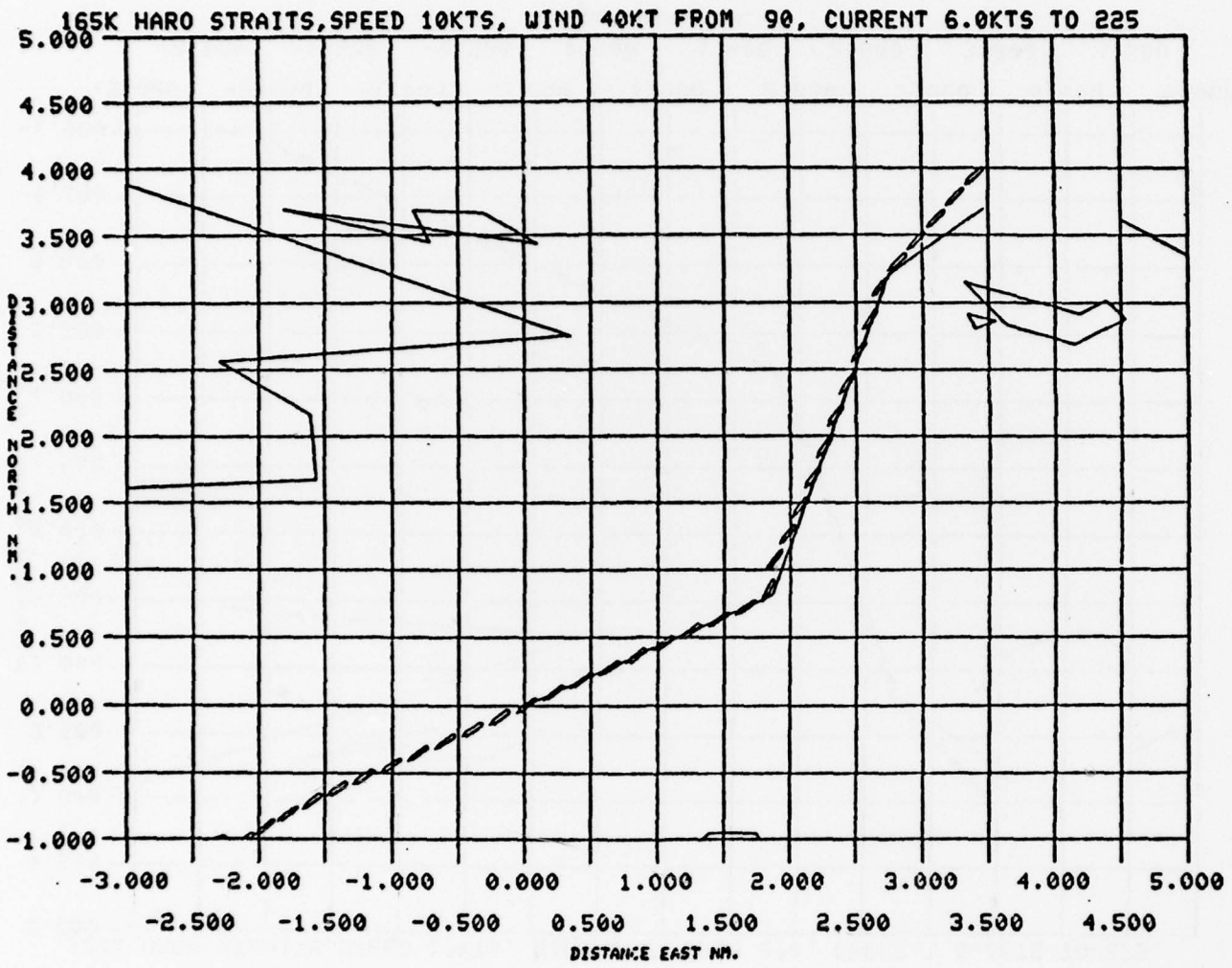
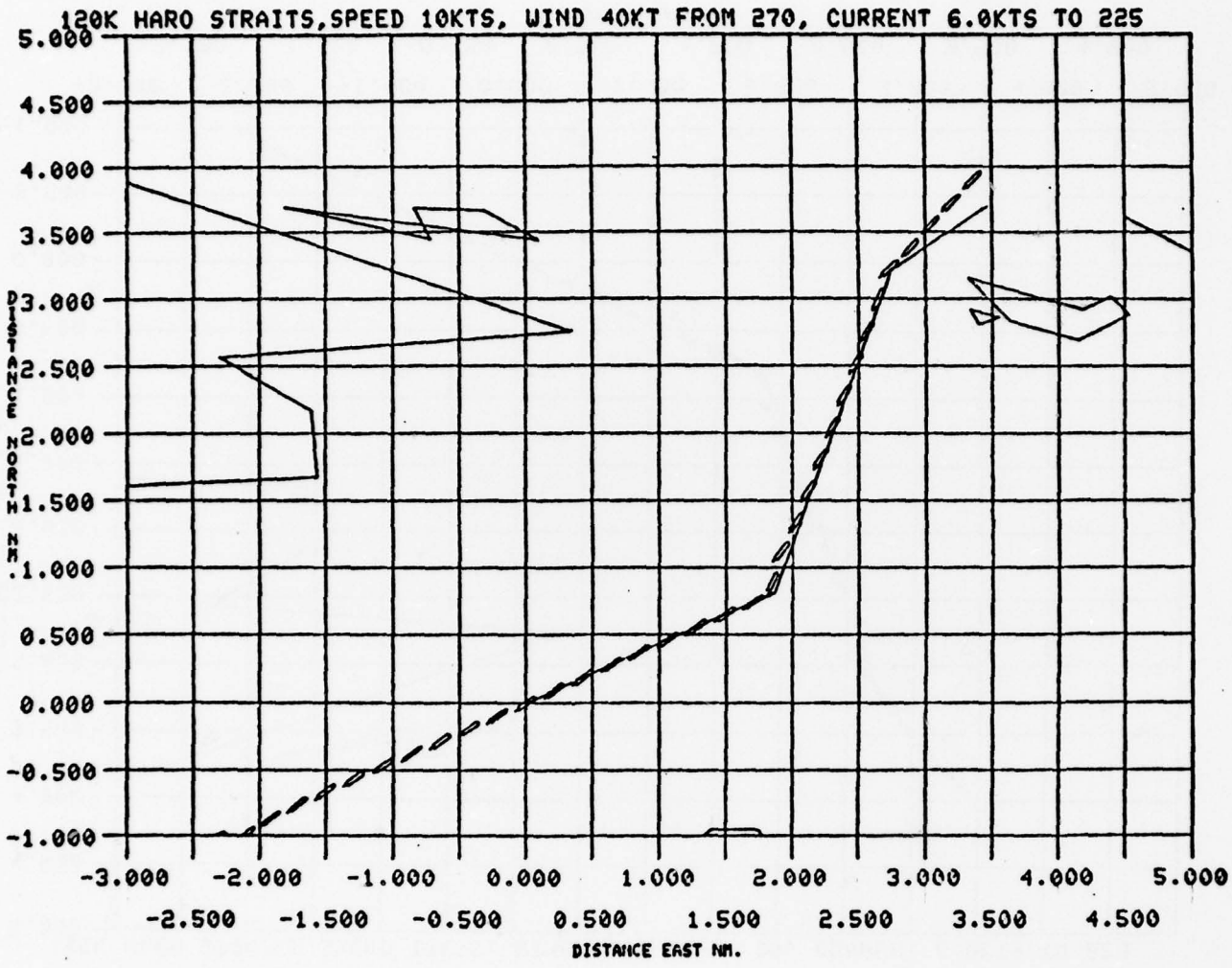
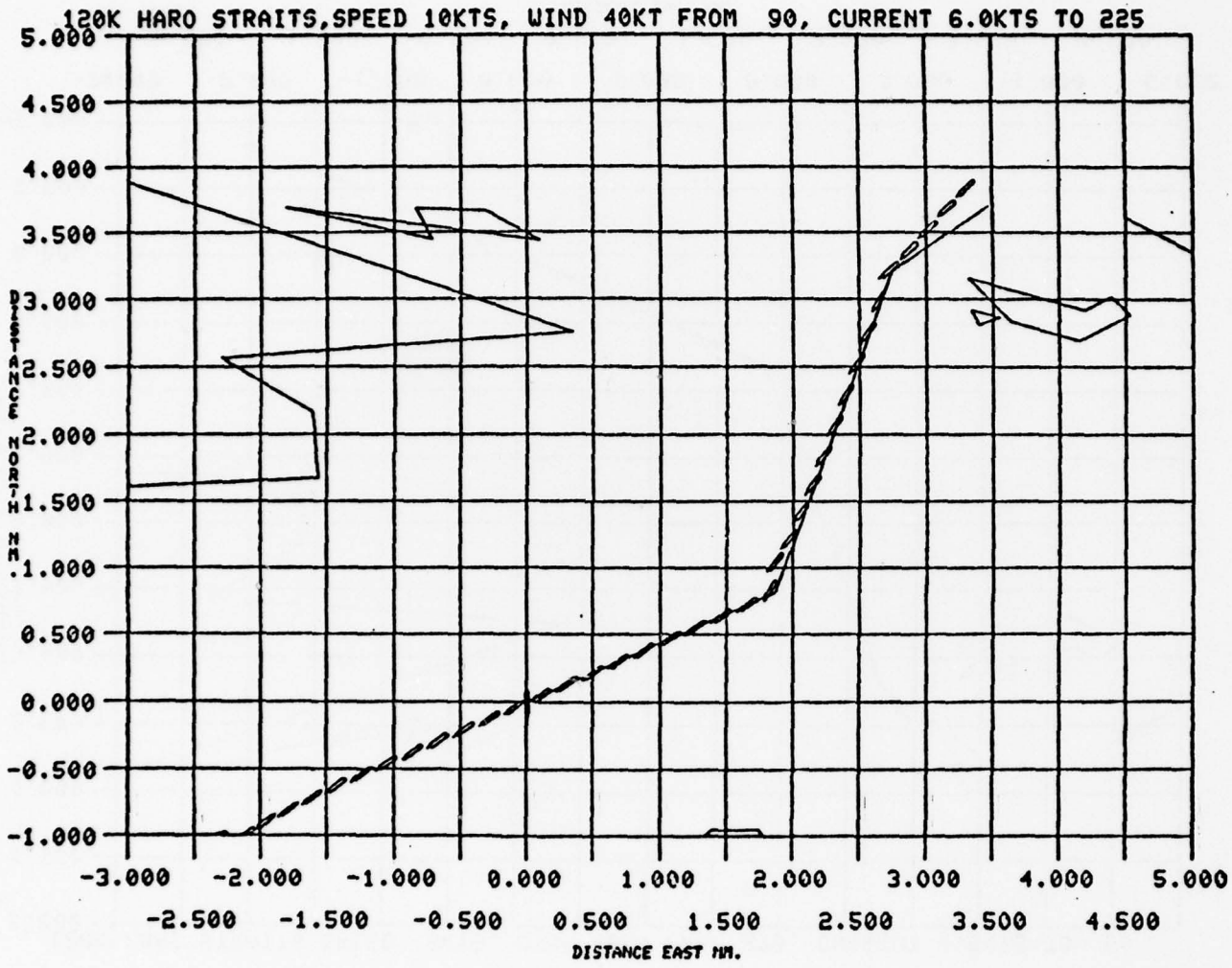
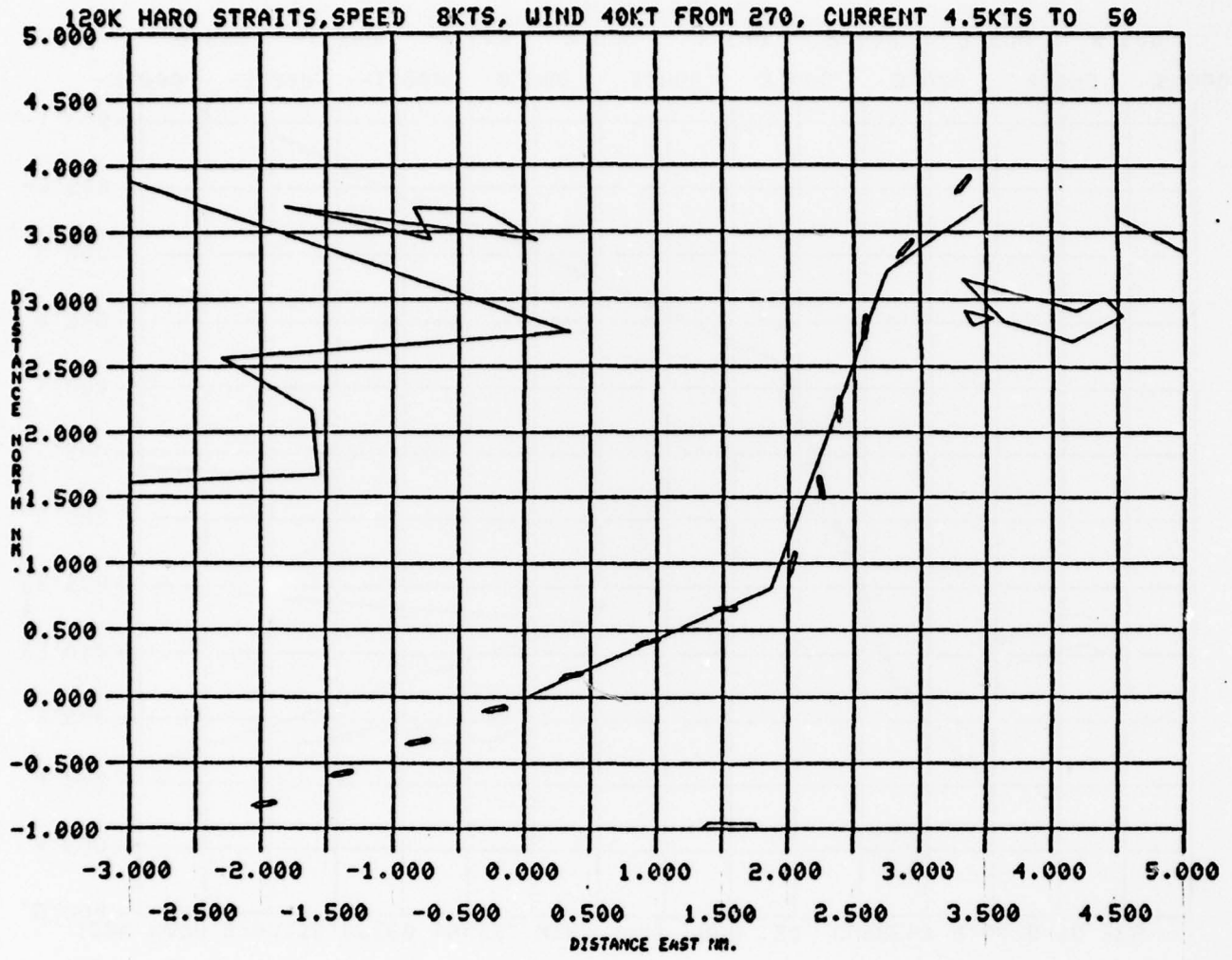
DATE FILMED
3-79
DDC

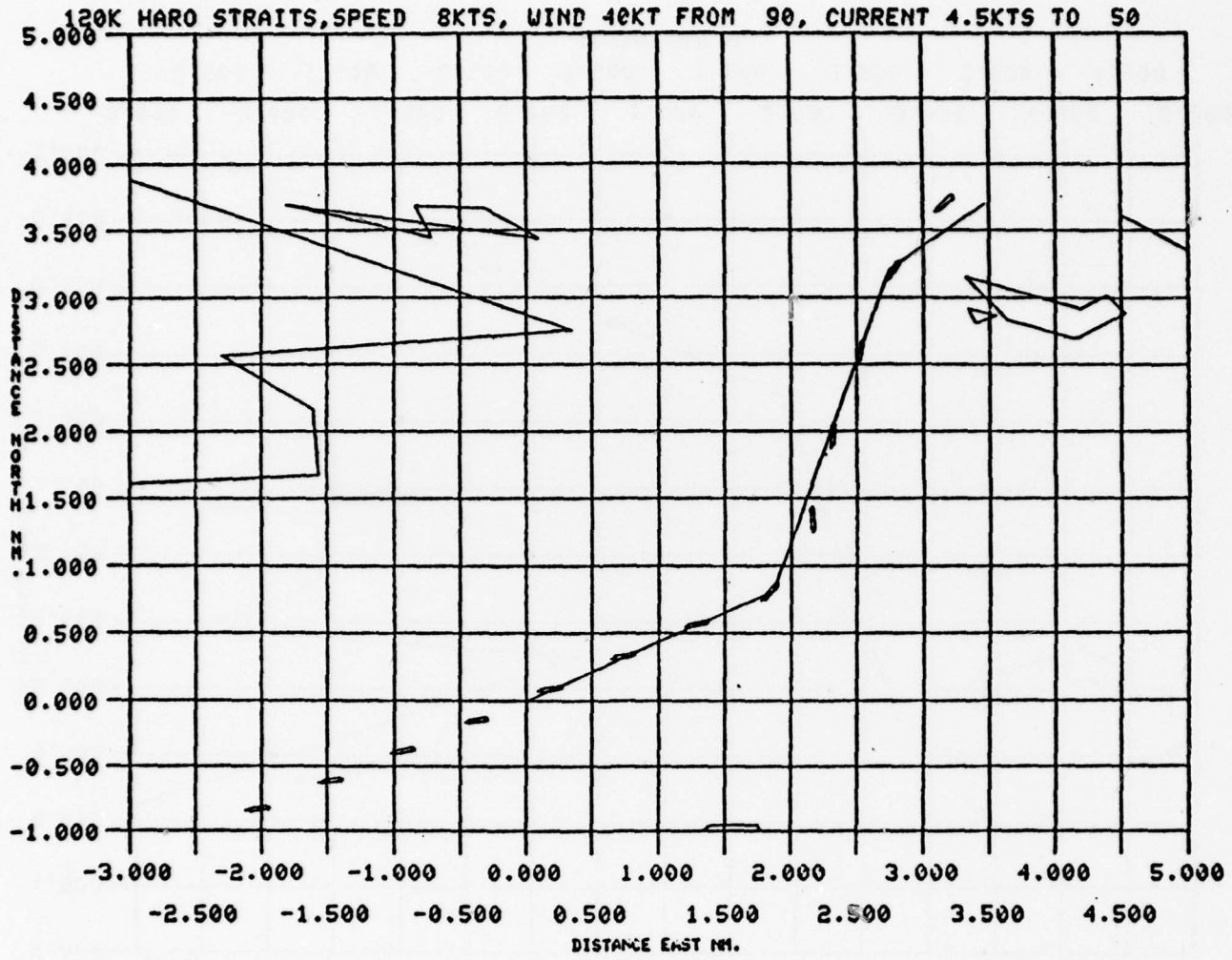

1.0
1.1
1.25
1.4
1.6
2.8
2.5
3.2
2.2
3.6
2.0
4.0
1.8
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

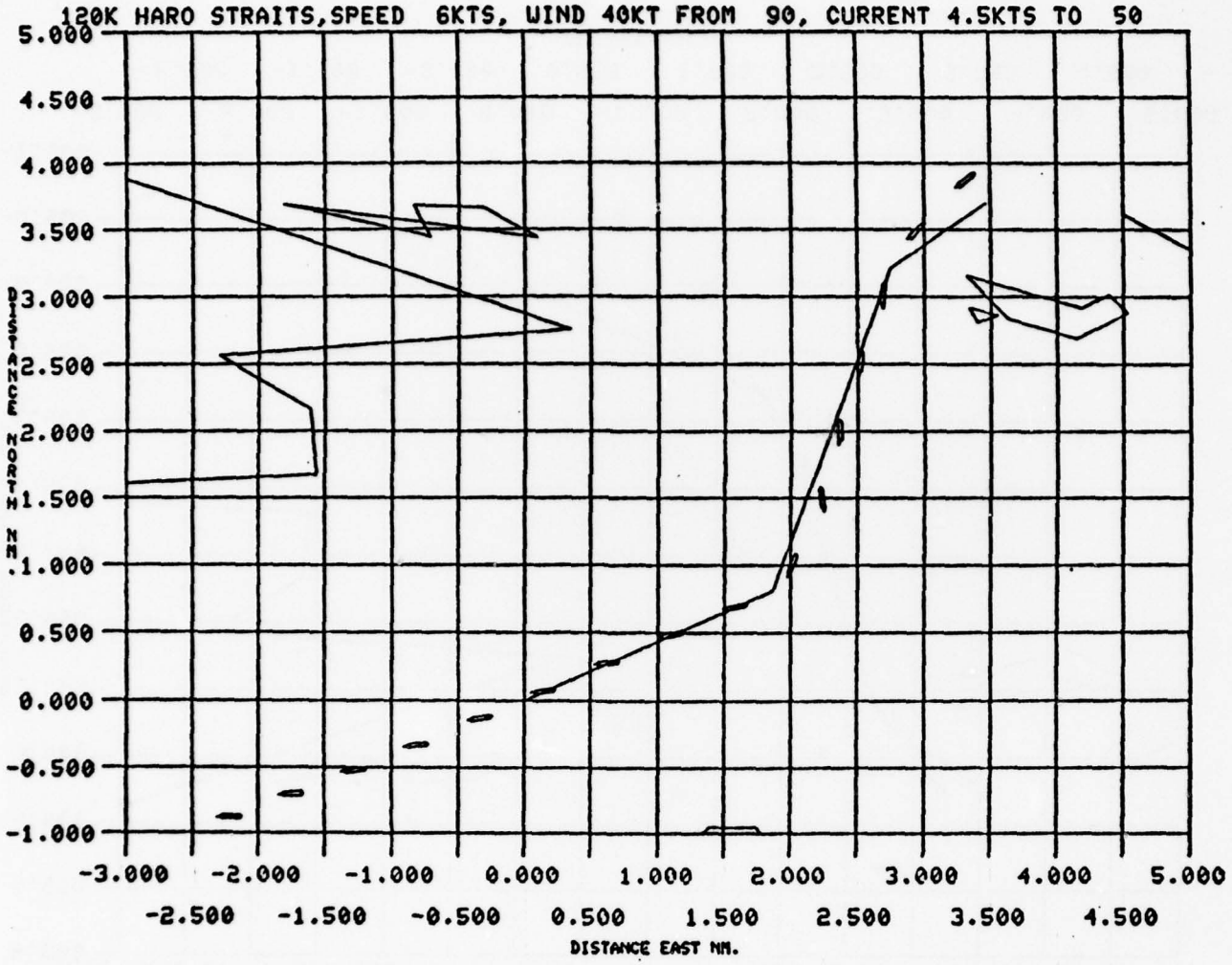

165K HARO STRAITS,SPEED 10KTS, WIND 40KT FROM 90, CURRENT 6.0KTS TO 225
5.000
4.500
4.000
3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
-0.500
-1.000
DISTANCE NORTH NM.
-3.000
-2.000
-1.000
0.000
1.000
2.000
3.000
4.000
5.000
-2.500
-1.500
-0.500
0.500
1.500
2.500
3.500
4.500
DISTANCE EAST NM.

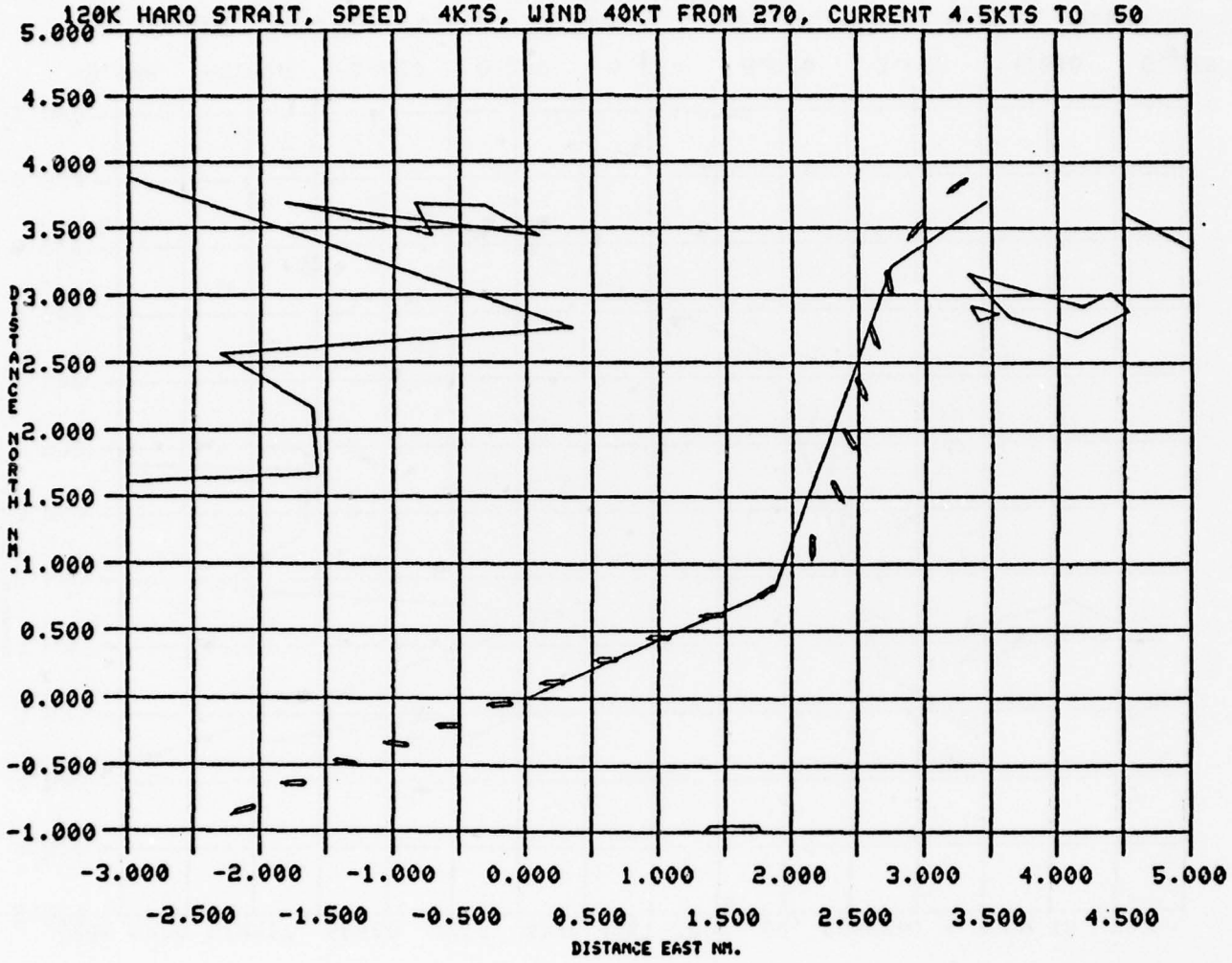

120K HARO STRAITS,SPEED 10KTS, WIND 40KT FROM 270, CURRENT 6.0KTS TO 225
5.000
4.500
4.000
3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
-0.500
-1.000
DISTANCE NORTH NM.
-3.000
-2.000
-1.000
0.000
1.000
2.000
3.000
4.000
5.000
-2.500
-1.500
-0.500
0.500
1.500
2.500
3.500
4.500
DISTANCE EAST NM.

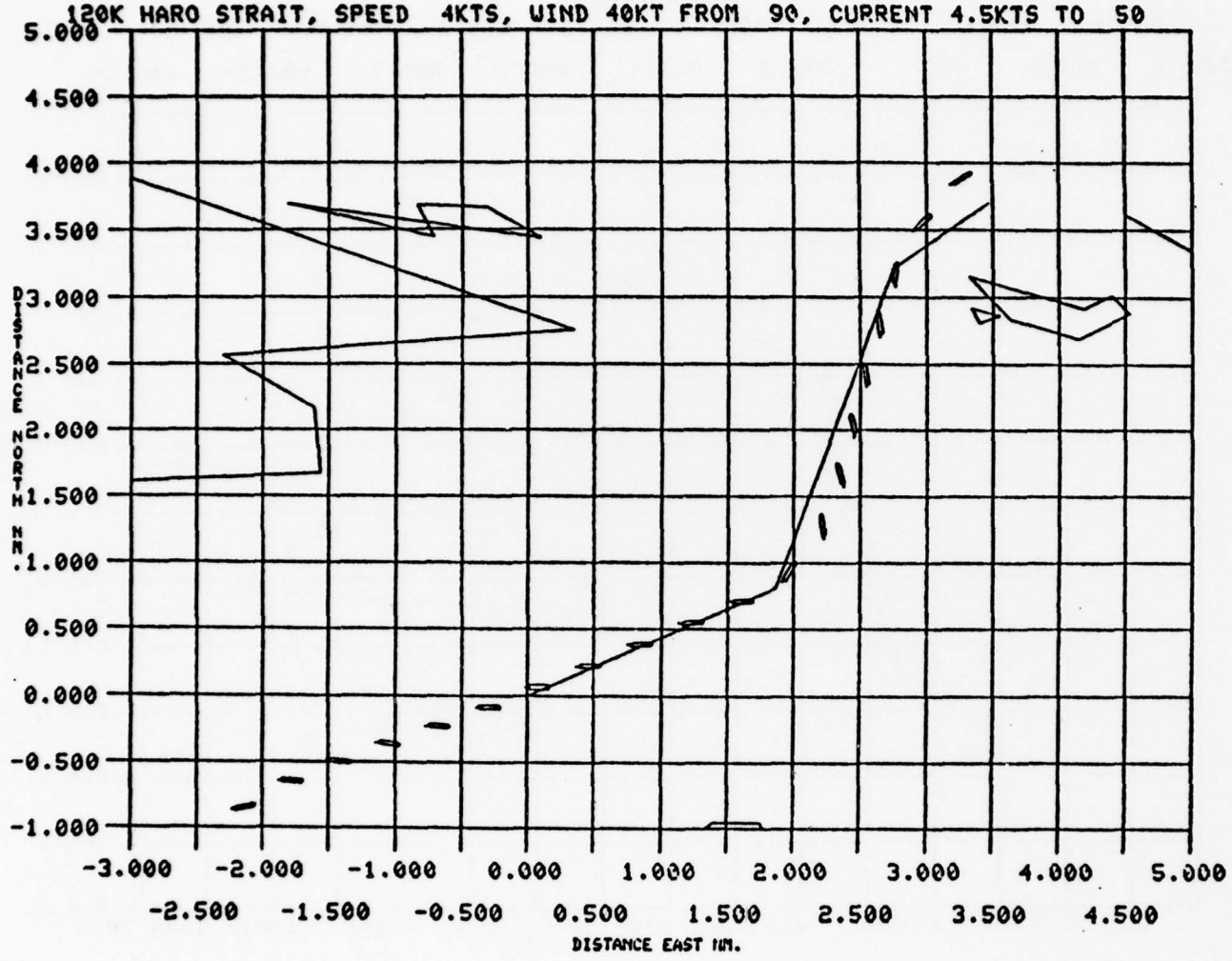

120K HARO STRAITS,SPEED 10KTS, WIND 40KT FROM 90, CURRENT 6.0KTS TO 225
5.000
4.500
4.000
3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
-0.500
-1.000
DISTANCE NORTH NM.
-3.000
-2.000
-1.000
0.000
1.000
2.000
3.000
4.000
5.000
-2.500
-1.500
-0.500
0.500
1.500
2.500
3.500
4.500
DISTANCE EAST NM.

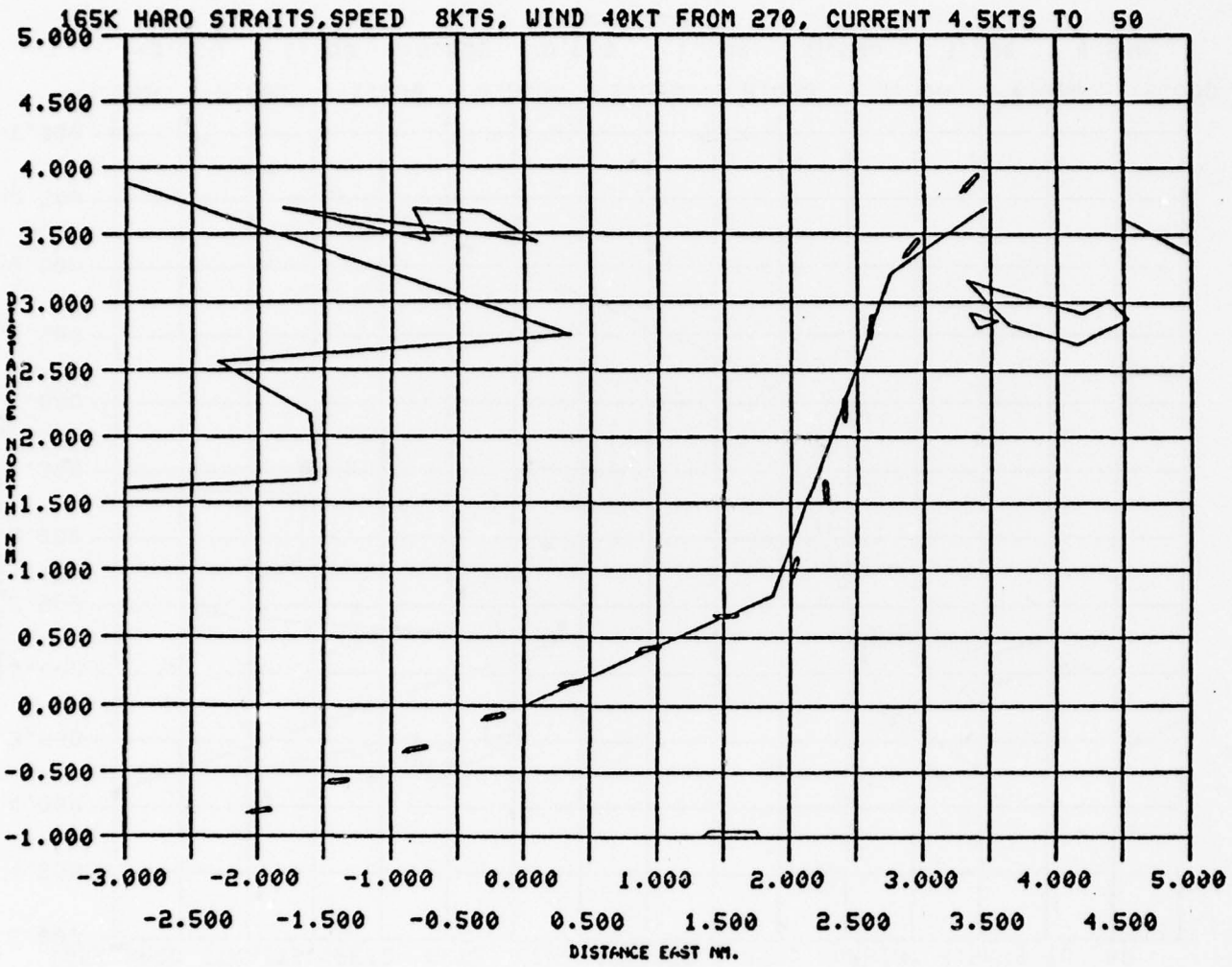

120K HARO STRAITS,SPEED 8KTS, WIND 40KT FROM 270, CURRENT 4.5KTS TO 50
5.000
4.500
4.000
3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
-0.500
-1.000
DISTANCE NORTH NM.
-3.000
-2.000
-1.000
0.000
1.000
2.000
3.000
4.000
5.000
-2.500
-1.500
-0.500
0.500
1.500
2.500
3.500
4.500
DISTANCE EAST NM.

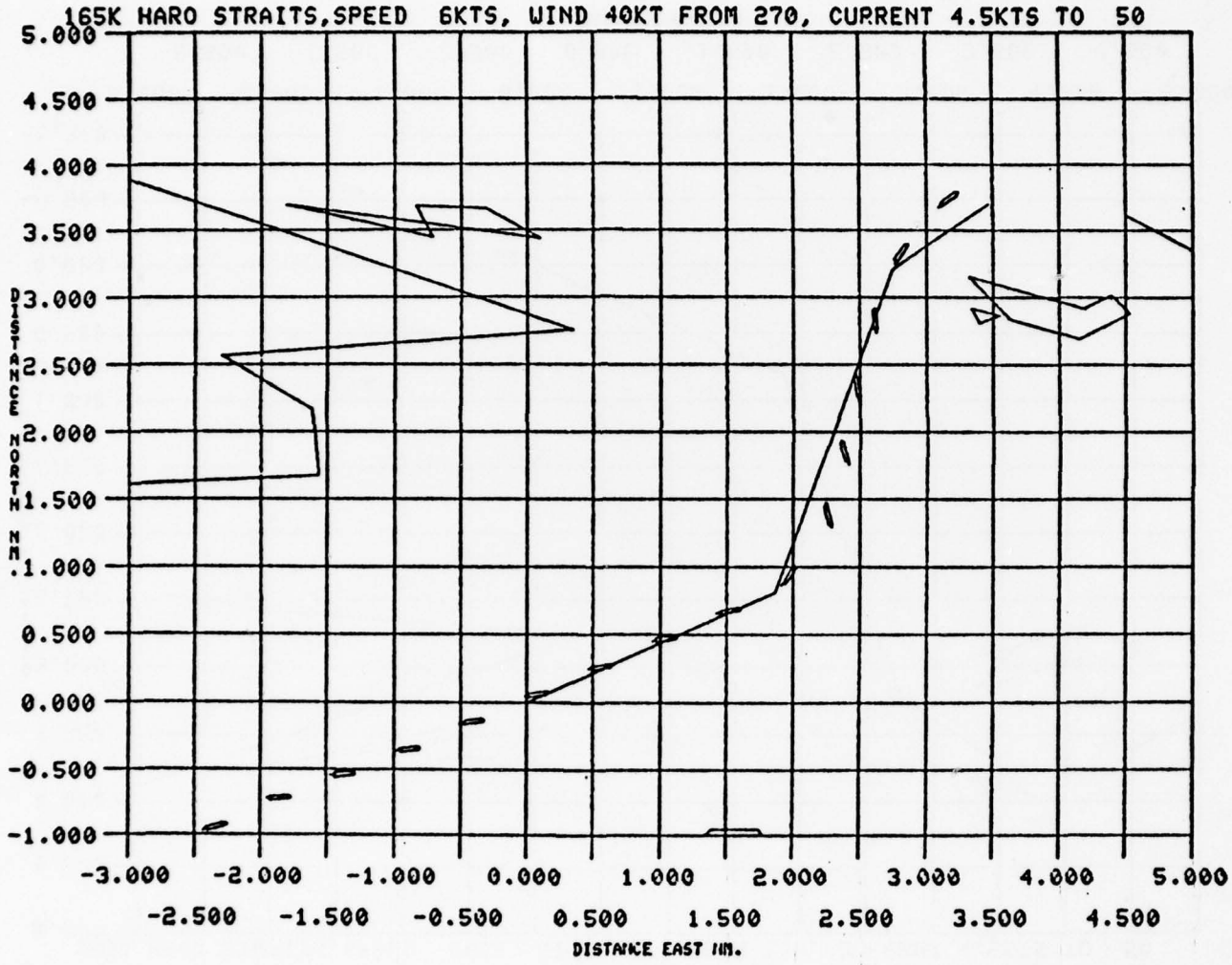

120K HARO STRAITS,SPEED 8KTS, WIND 40KT FROM 90, CURRENT 4.5KTS TO 50
5.000
4.500
4.000
3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
-0.500
-1.000
DISTANCE NORTH NM.
-3.000
-2.000
-1.000
0.000
1.000
2.000
3.000
4.000
5.000
-2.500
-1.500
-0.500
0.500
1.500
2.500
3.500
4.500
DISTANCE EAST NM.

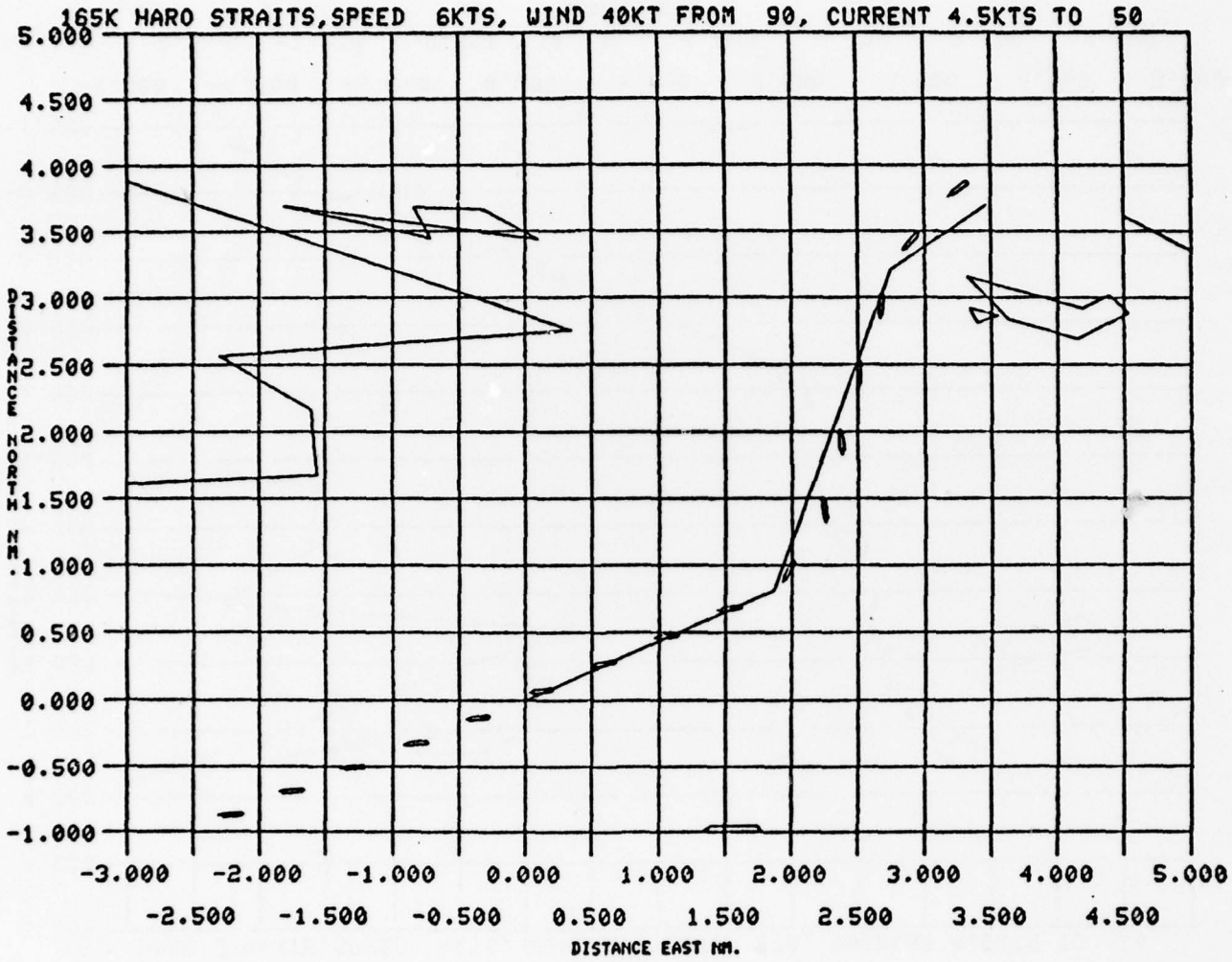

120K HARO STRAITS,SPEED 6KTS, WIND 40KT FROM 90, CURRENT 4.5KTS TO 50
5.000
4.500
4.000
3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
-0.500
-1.000
DISTANCE NORTH NM.
-3.000 -2.000 -1.000 0.000 1.000 2.000 3.000 4.000 5.000
-2.500 -1.500 -0.500 0.500 1.500 2.500 3.500 4.500
DISTANCE EAST NM.

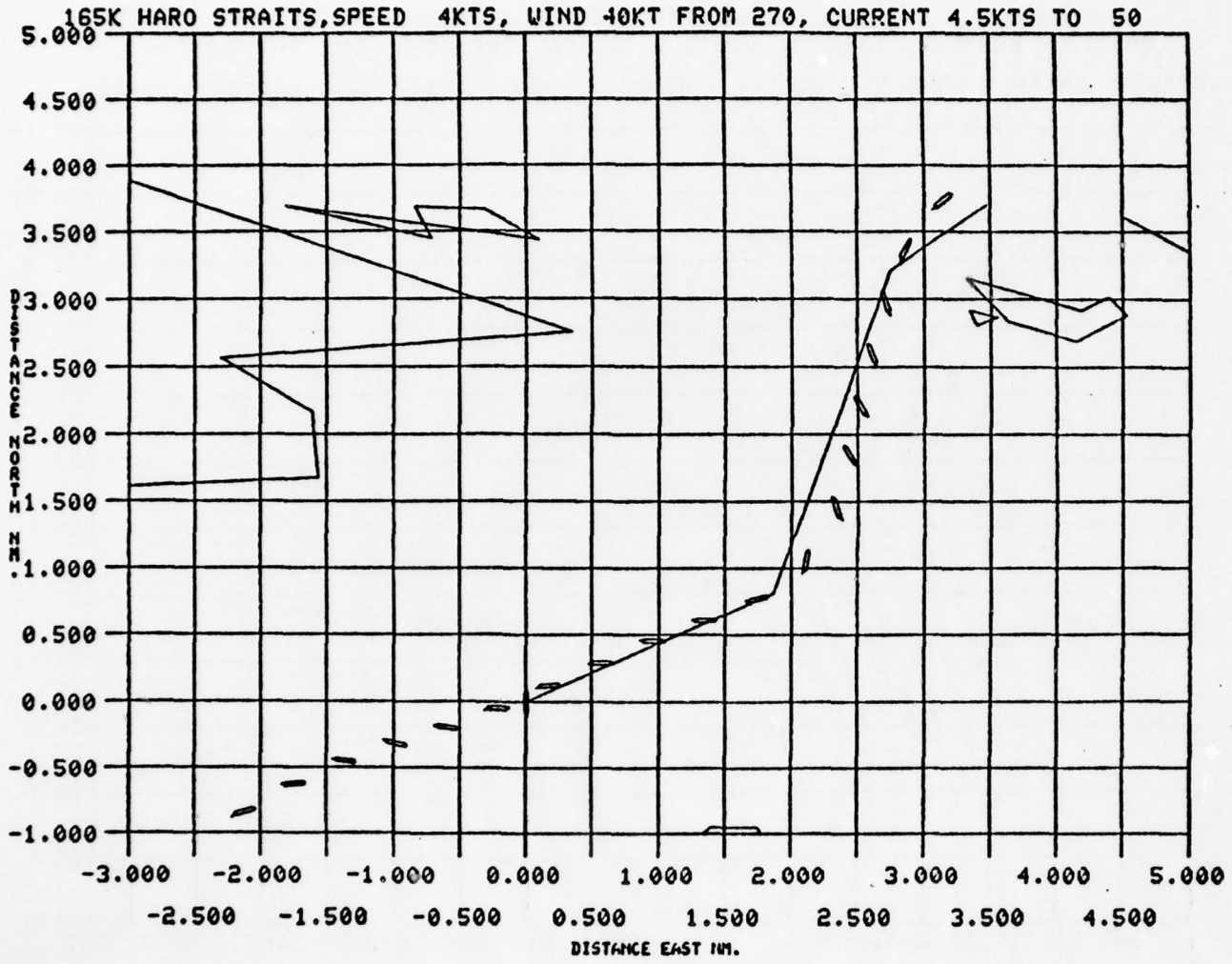

120K HARO STRAIT, SPEED 4KTS, WIND 40KT FROM 270, CURRENT 4.5KTS TO 50
5.000
4.500
4.000
3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
-0.500
-1.000
DISTANCE NORTH NM.
-3.000
-2.000
-1.000
0.000
1.000
2.000
3.000
4.000
5.000
-2.500
-1.500
-0.500
0.500
1.500
2.500
3.500
4.500
DISTANCE EAST NM.

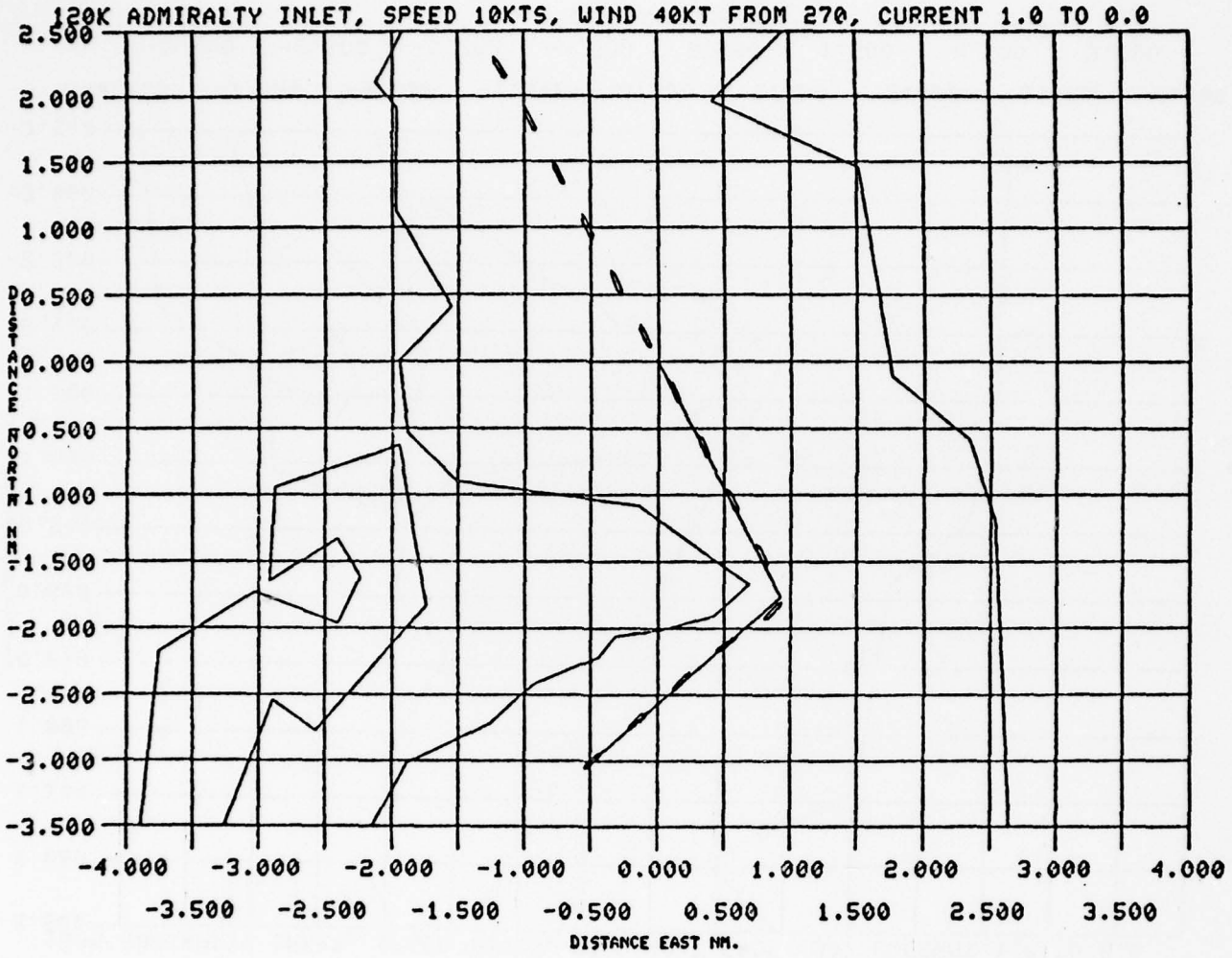

120K HARO STRAIT, SPEED 4KTS, WIND 40KT FROM 90, CURRENT 4.5KTS TO 50
5.000
4.500
4.000
3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
-0.500
-1.000
DISTANCE NORTH NM.
-3.000
-2.000
-1.000
0.000
1.000
2.000
3.000
4.000
5.000
-2.500
-1.500
-0.500
0.500
1.500
2.500
3.500
4.500
DISTANCE EAST NM.

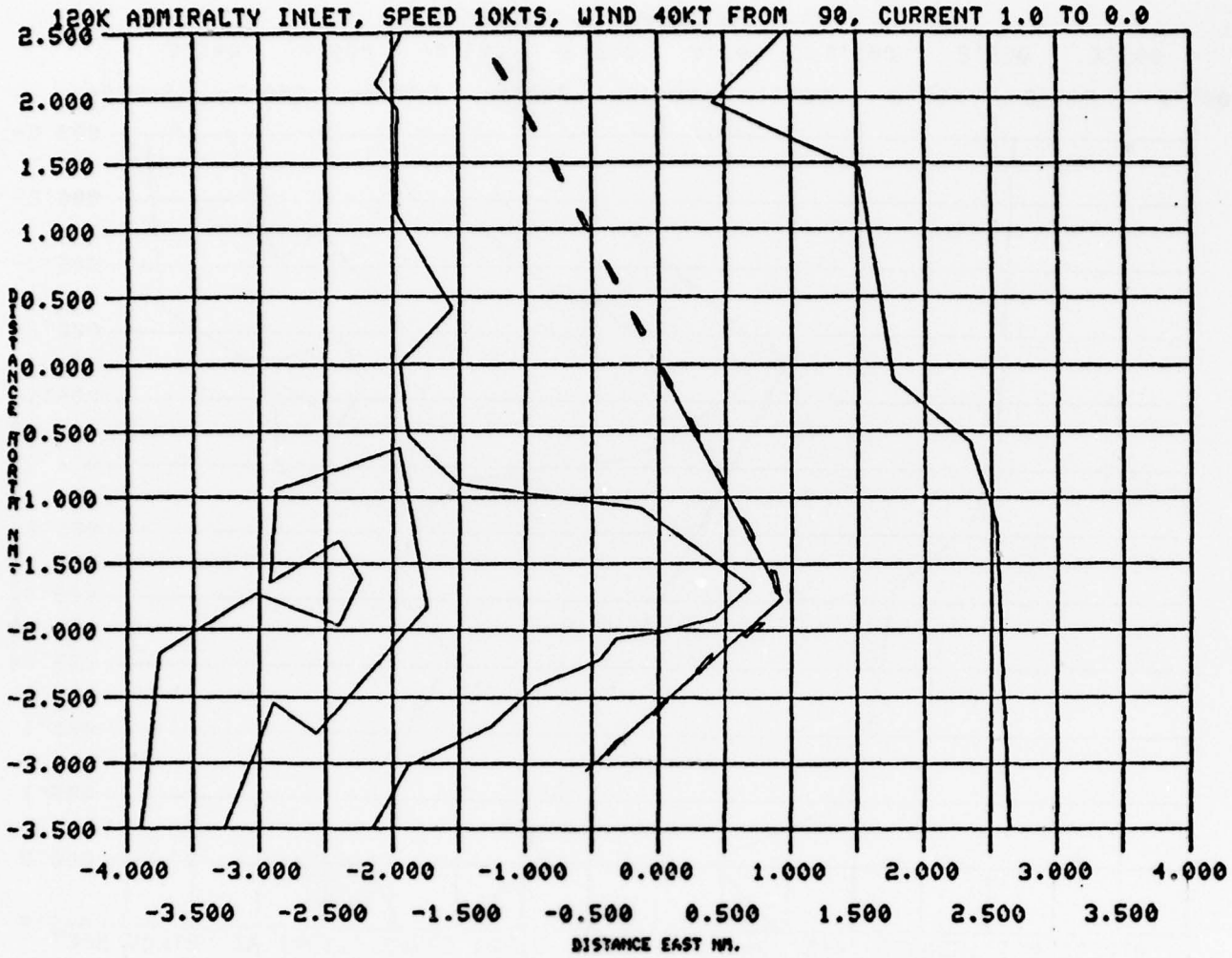

165K HARO STRAITS,SPEED 8KTS, WIND 40KT FROM 270, CURRENT 4.5KTS TO 50
5.000
4.500
4.000
3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
-0.500
-1.000
DISTANCE NORTH NM.
-3.000
-2.000
-1.000
0.000
1.000
2.000
3.000
4.000
5.000
-2.500
-1.500
-0.500
0.500
1.500
2.500
3.500
4.500
DISTANCE EAST NM.

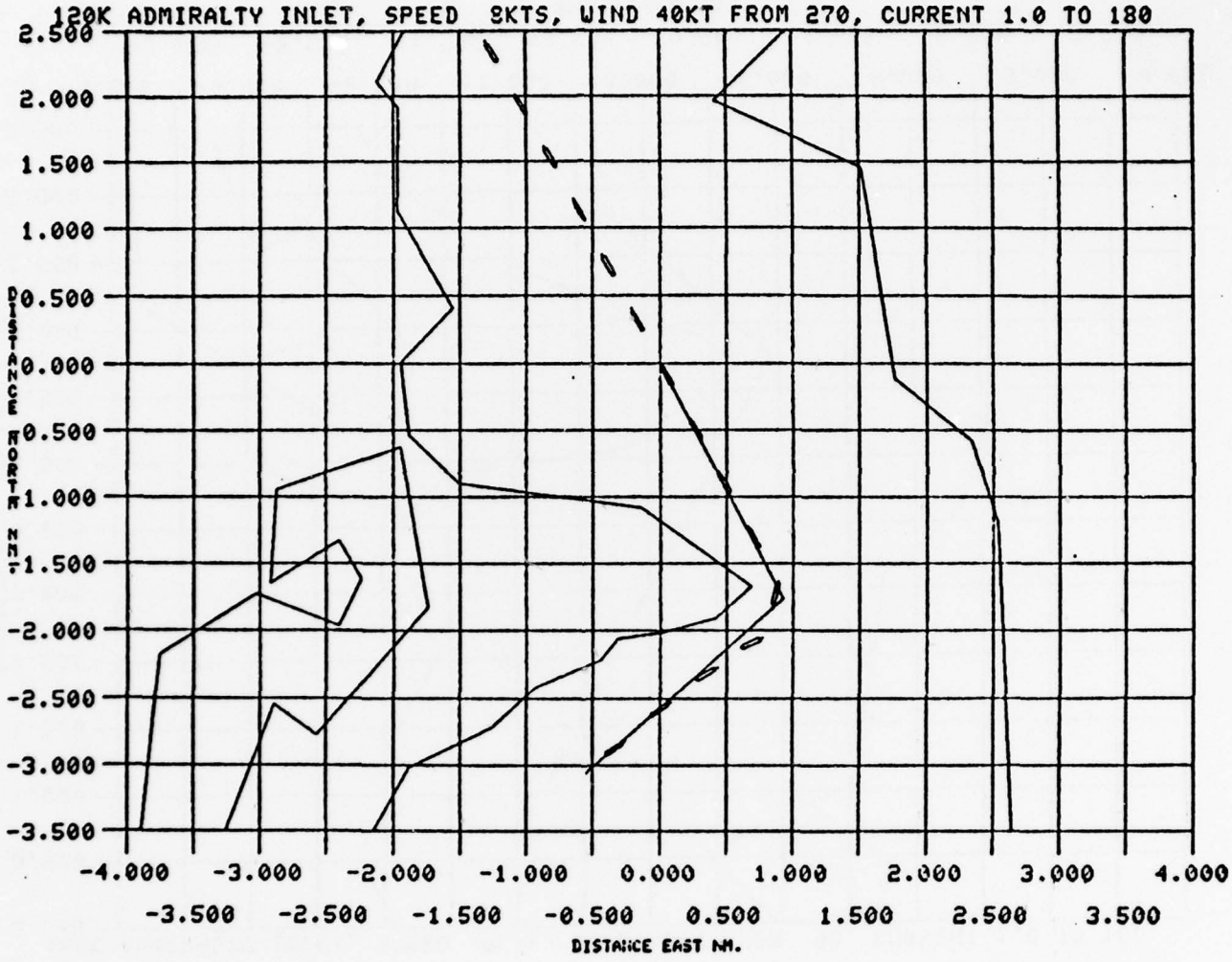

165K HARO STRAITS,SPEED 6KTS, WIND 40KT FROM 270, CURRENT 4.5KTS TO 50
5.000
4.500
4.000
3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
-0.500
-1.000
DISTANCE NORTH NM.
-3.000
-2.000
-1.000
0.000
1.000
2.000
3.000
4.000
5.000
-2.500
-1.500
-0.500
0.500
1.500
2.500
3.500
4.500
DISTANCE EAST NM.

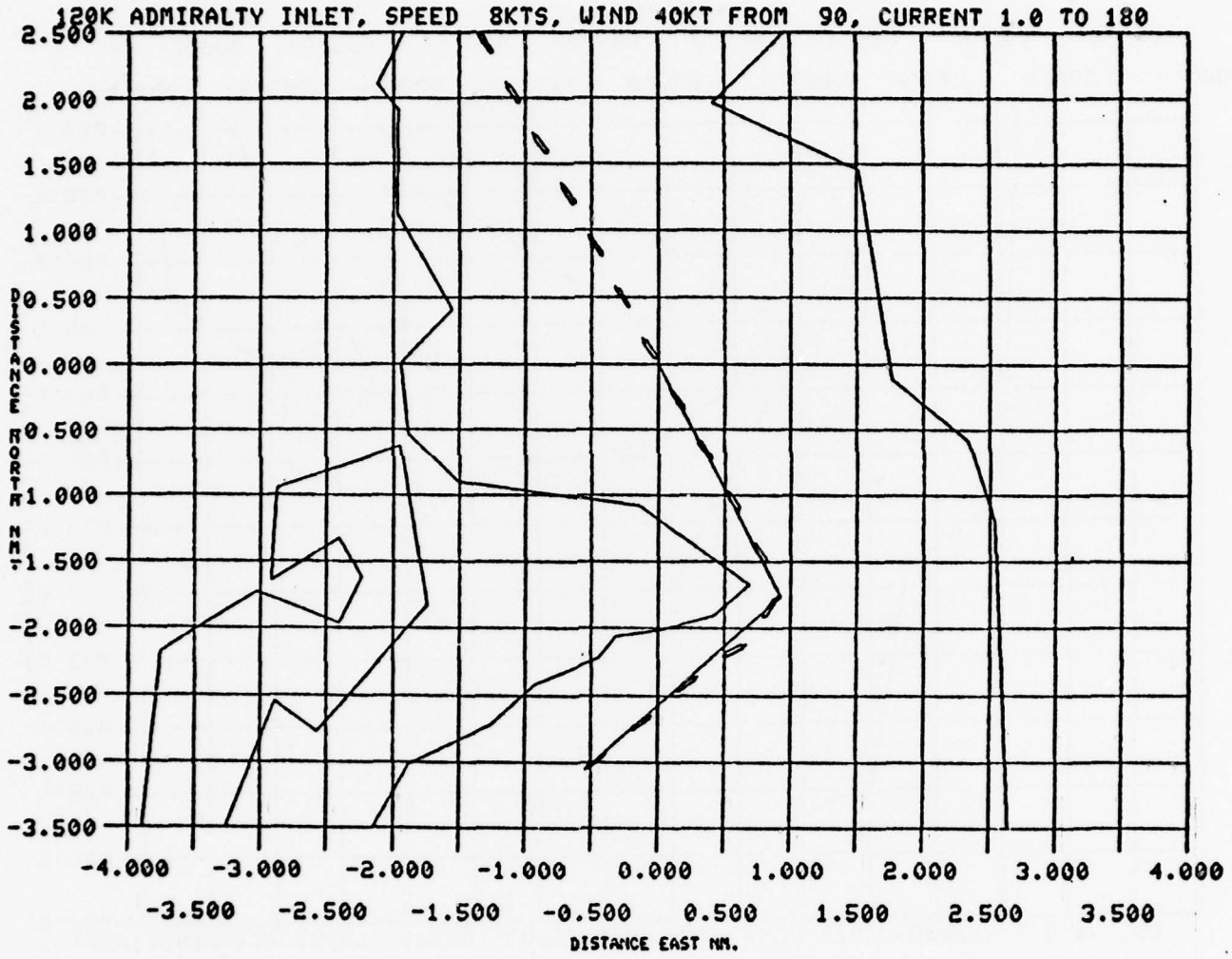

165K HARO STRAITS,SPEED 6KTS, WIND 40KT FROM 90, CURRENT 4.5KTS TO 50
5.000
4.500
4.000
3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
-0.500
-1.000
DISTANCE NORTH NM.
-3.000
-2.000
-1.000
0.000
1.000
2.000
3.000
4.000
5.000
-2.500
-1.500
-0.500
0.500
1.500
2.500
3.500
4.500
DISTANCE EAST NM.

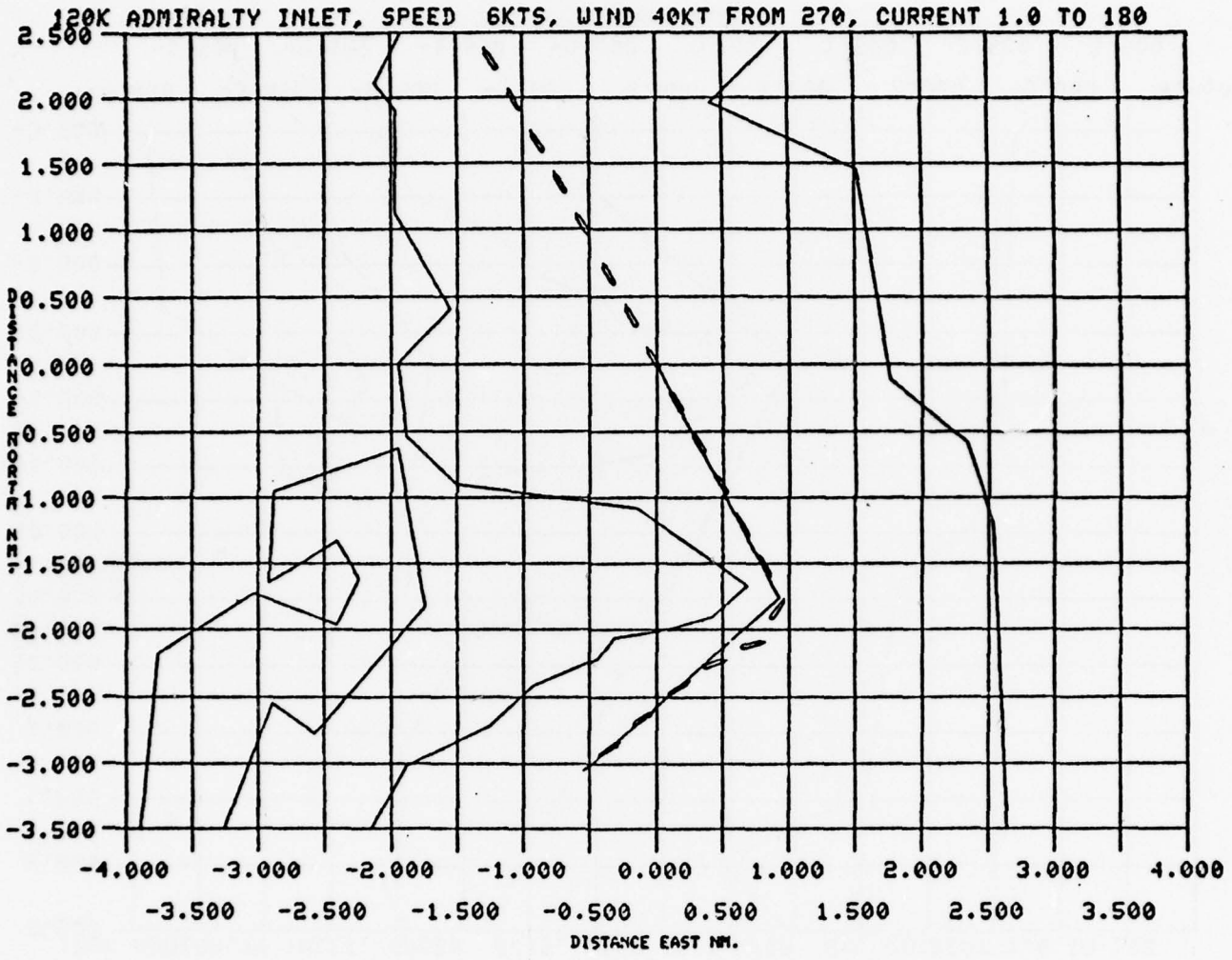

165K HARO STRAITS,SPEED 4KTS, WIND 10KT FROM 270, CURRENT 4.5KTS TO 50
5.000
4.500
4.000
3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
-0.500
-1.000
DISTANCE NORTH NM.
-3.000
-2.000
-1.000
0.000
1.000
2.000
3.000
4.000
5.000
-2.500
-1.500
-0.500
0.500
1.500
2.500
3.500
4.500
DISTANCE EAST NM.

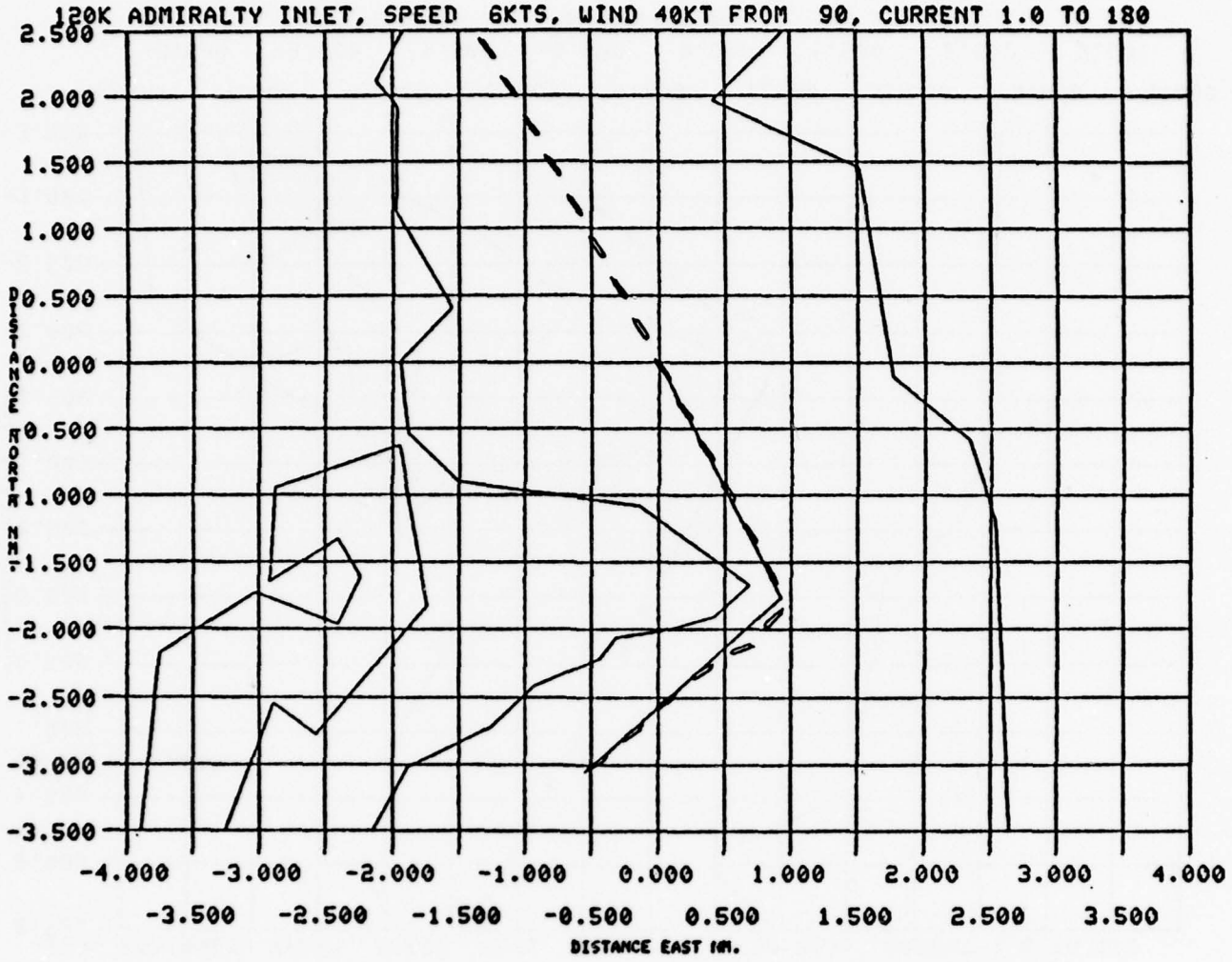

120K ADMIRALTY INLET, SPEED 10KTS, WIND 40KT FROM 270, CURRENT 1.0 TO 0.0
2.500
2.000
1.500
1.000
0.500
0.000
0.500
1.000
1.500
-2.000
-2.500
-3.000
-3.500
DISTANCE NORTH NM.
-4.000
-3.000
-2.000
-1.000
0.000
1.000
2.000
3.000
4.000
-3.500
-2.500
-1.500
-0.500
0.500
1.500
2.500
3.500
DISTANCE EAST NM.

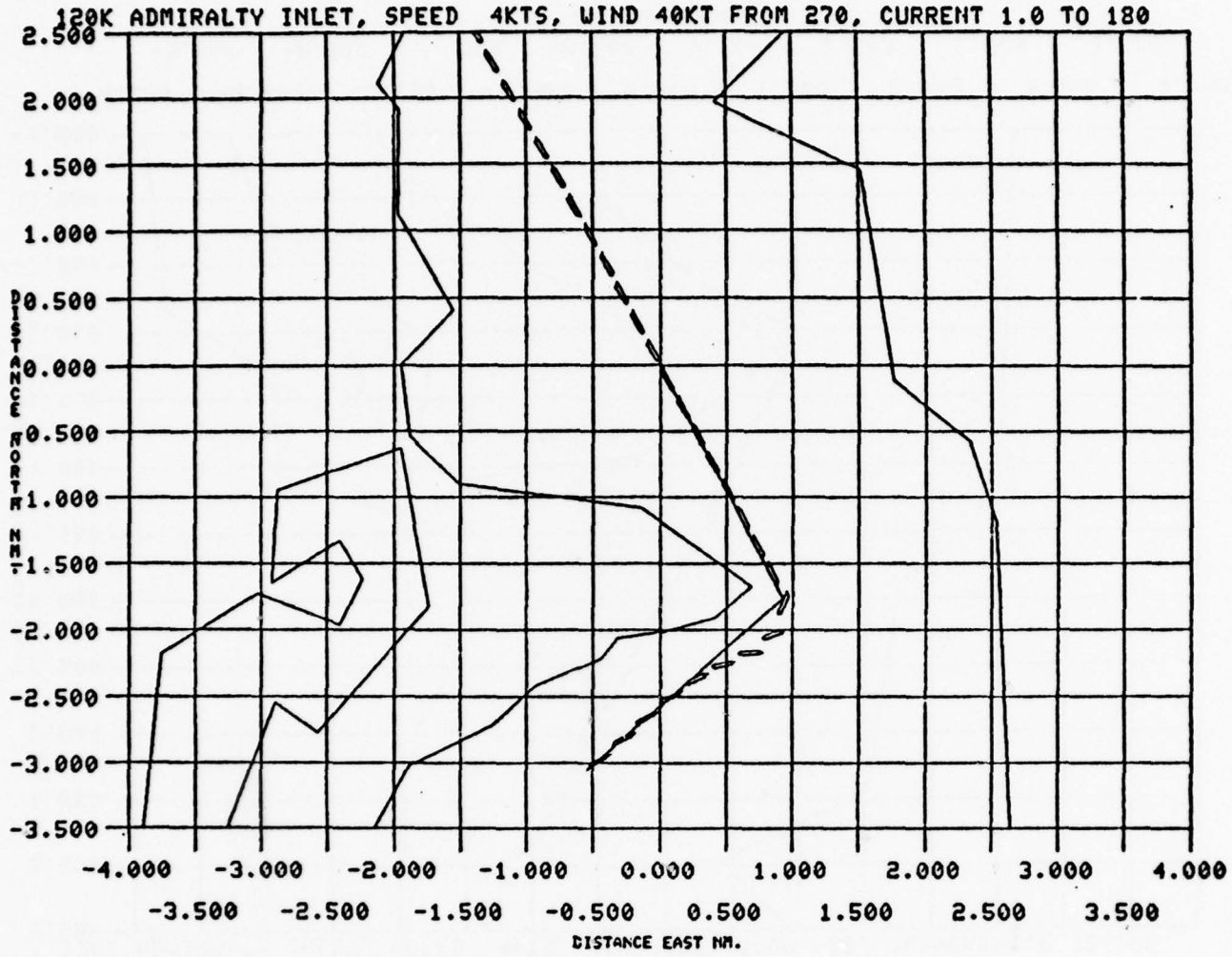

120K ADMIRALTY INLET, SPEED 10KTS, WIND 40KT FROM 90, CURRENT 1.0 TO 0.0
2.500
2.000
1.500
1.000
0.500
0.000
0.500
1.000
1.500
-2.000
-2.500
-3.000
-3.500
DISTANCE NORTH NM.
-4.000 -3.000 -2.000 -1.000 0.000 1.000 2.000 3.000 4.000
-3.500 -2.500 -1.500 -0.500 0.500 1.500 2.500 3.500
DISTANCE EAST NM.

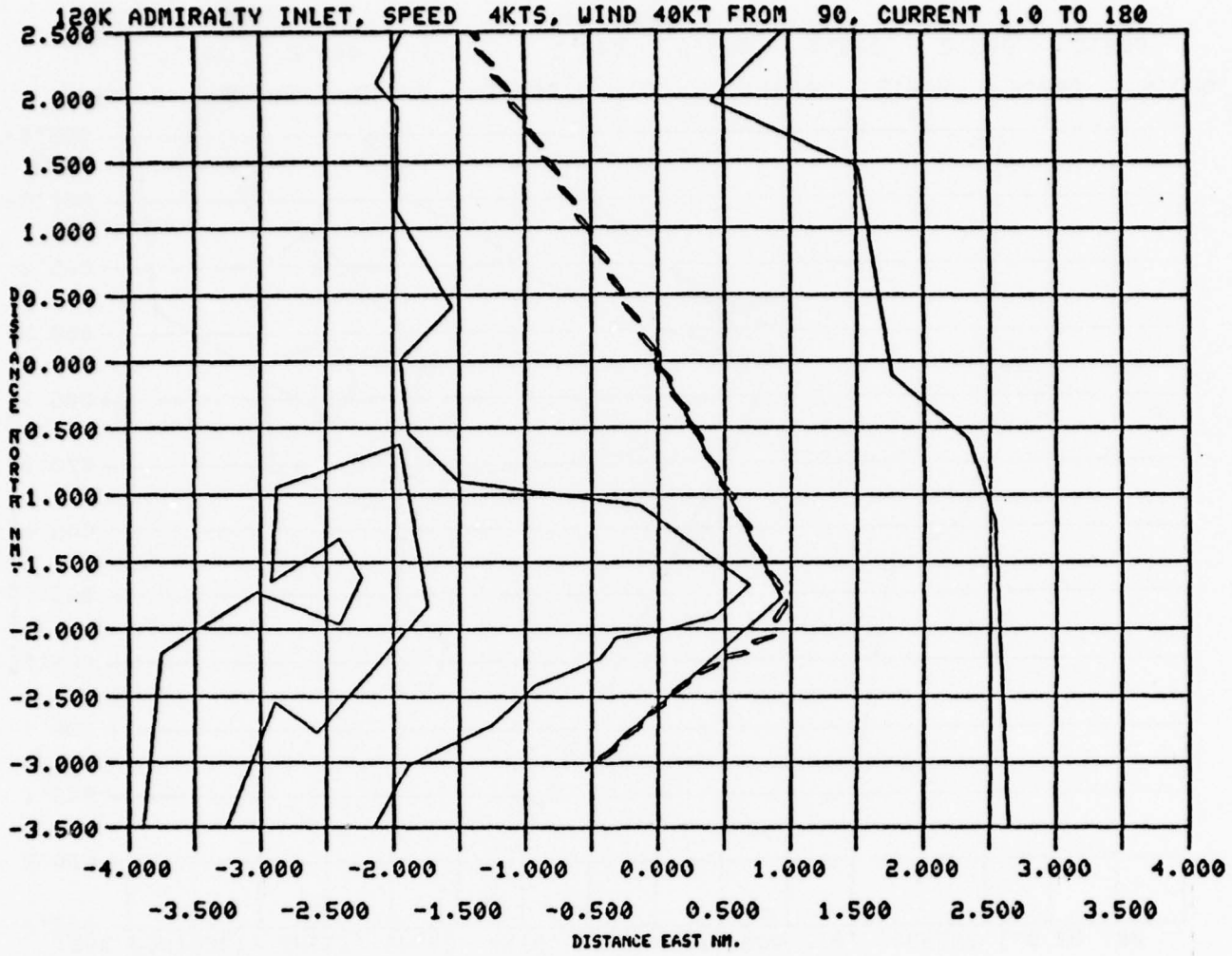

120K ADMIRALTY INLET, SPEED 8KTS, WIND 40KT FROM 270, CURRENT 1.0 TO 180
2.500
2.000
1.500
1.000
0.500
0.000
0.500
1.000
1.500
-2.000
-2.500
-3.000
-3.500
DISTANCE NORTH NM.
-4.000
-3.000
-2.000
-1.000
0.000
1.000
2.000
3.000
4.000
-3.500
-2.500
-1.500
-0.500
0.500
1.500
2.500
3.500
DISTANCE EAST NM.

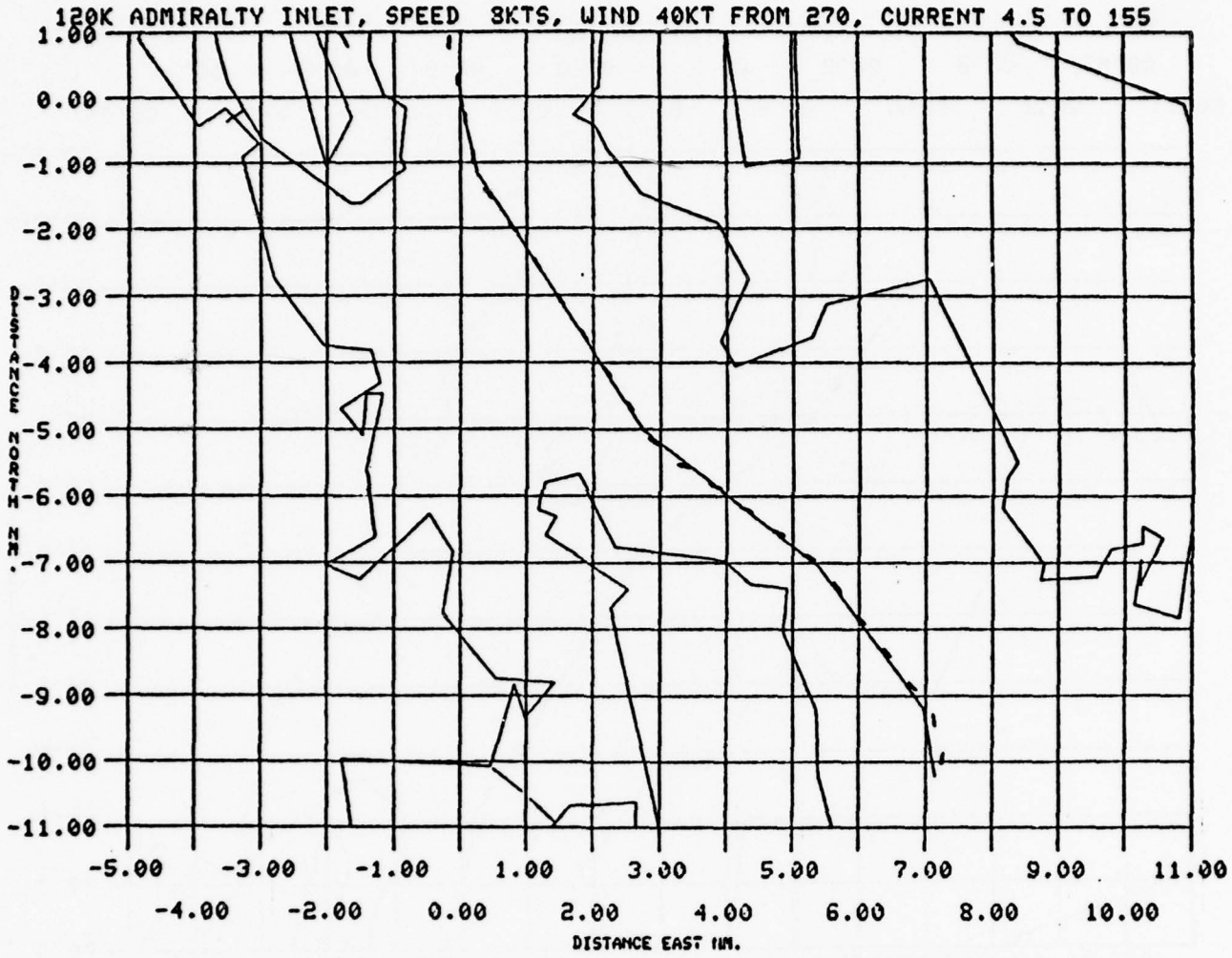

120K ADMIRALTY INLET, SPEED 8KTS, WIND 40KT FROM 90, CURRENT 1.0 TO 180
2.500
2.000
1.500
1.000
0.500
0.000
0.500
1.000
1.500
-2.000
-2.500
-3.000
-3.500
DISTANCE NORTH NM.
-4.000 -3.000 -2.000 -1.000 0.000 1.000 2.000 3.000 4.000
-3.500 -2.500 -1.500 -0.500 0.500 1.500 2.500 3.500
DISTANCE EAST NM.

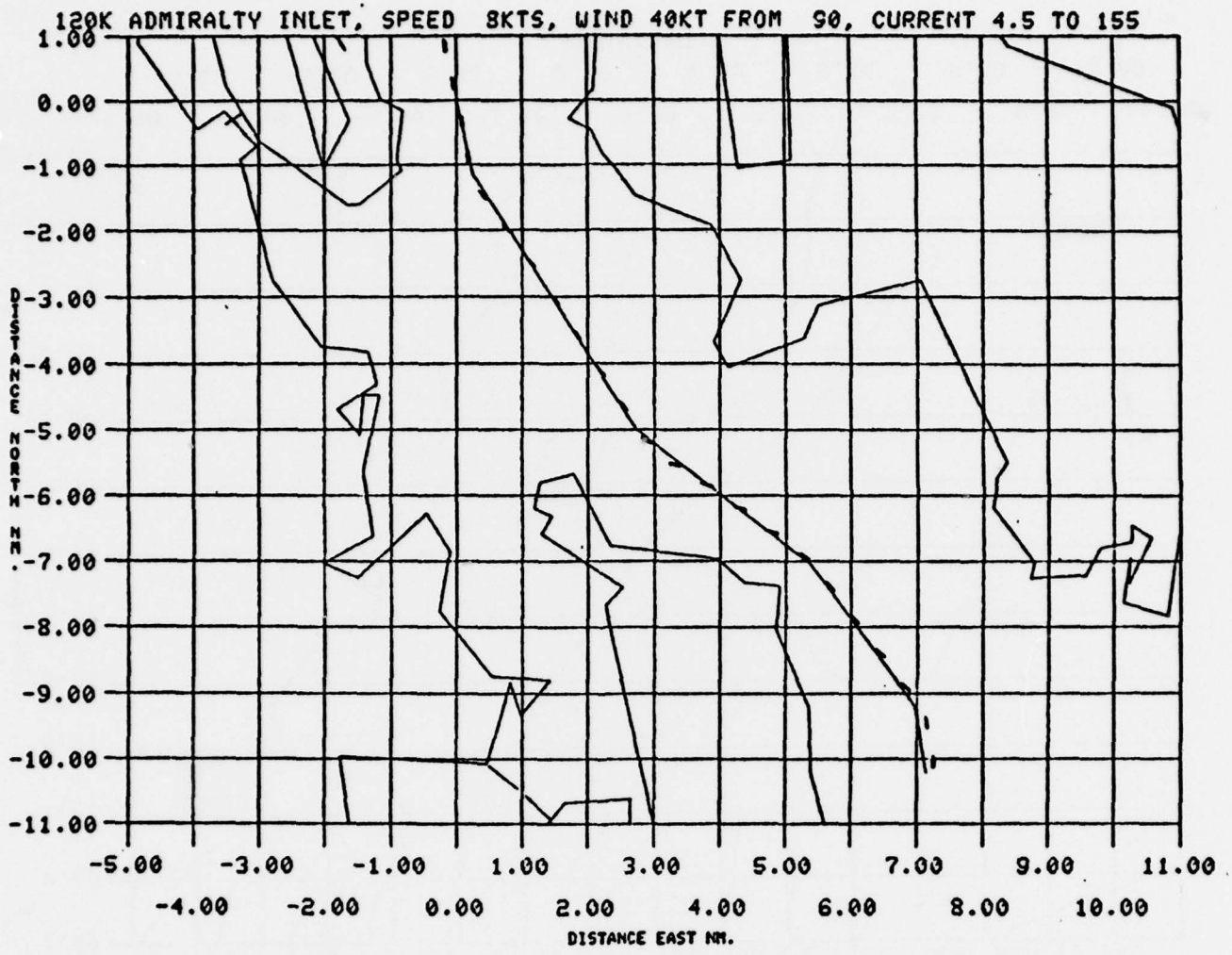

120K ADMIRALTY INLET, SPEED 6KTS, WIND 40KT FROM 270, CURRENT 1.0 TO 180
2.500
2.000
1.500
1.000
0.500
0.000
0.500
1.000
1.500
-2.000
-2.500
-3.000
-3.500
DISTANCE NORTH NM.
-4.000 -3.000 -2.000 -1.000 0.000 1.000 2.000 3.000 4.000
-3.500 -2.500 -1.500 -0.500 0.500 1.500 2.500 3.500
DISTANCE EAST NM.

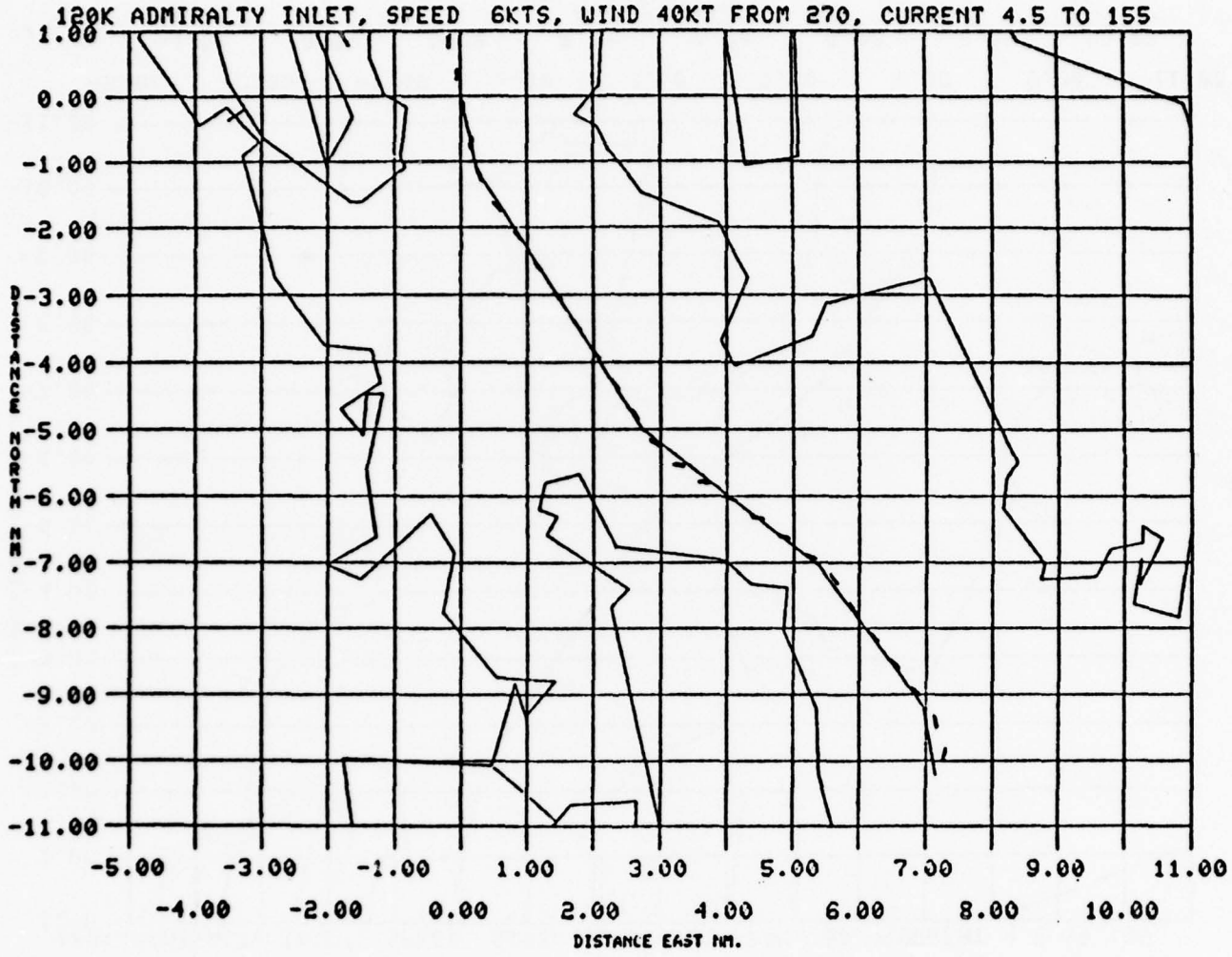

120K ADMIRALTY INLET, SPEED 6KTS, WIND 40KT FROM 90, CURRENT 1.0 TO 180
2.500
2.000
1.500
1.000
0.500
0.000
0.500
1.000
1.500
-2.000
-2.500
-3.000
-3.500
DISTANCE NORTH NM.
-4.000
-3.000
-2.000
-1.000
0.000
1.000
2.000
3.000
4.000
-3.500
-2.500
-1.500
-0.500
0.500
1.500
2.500
3.500
DISTANCE EAST NM.

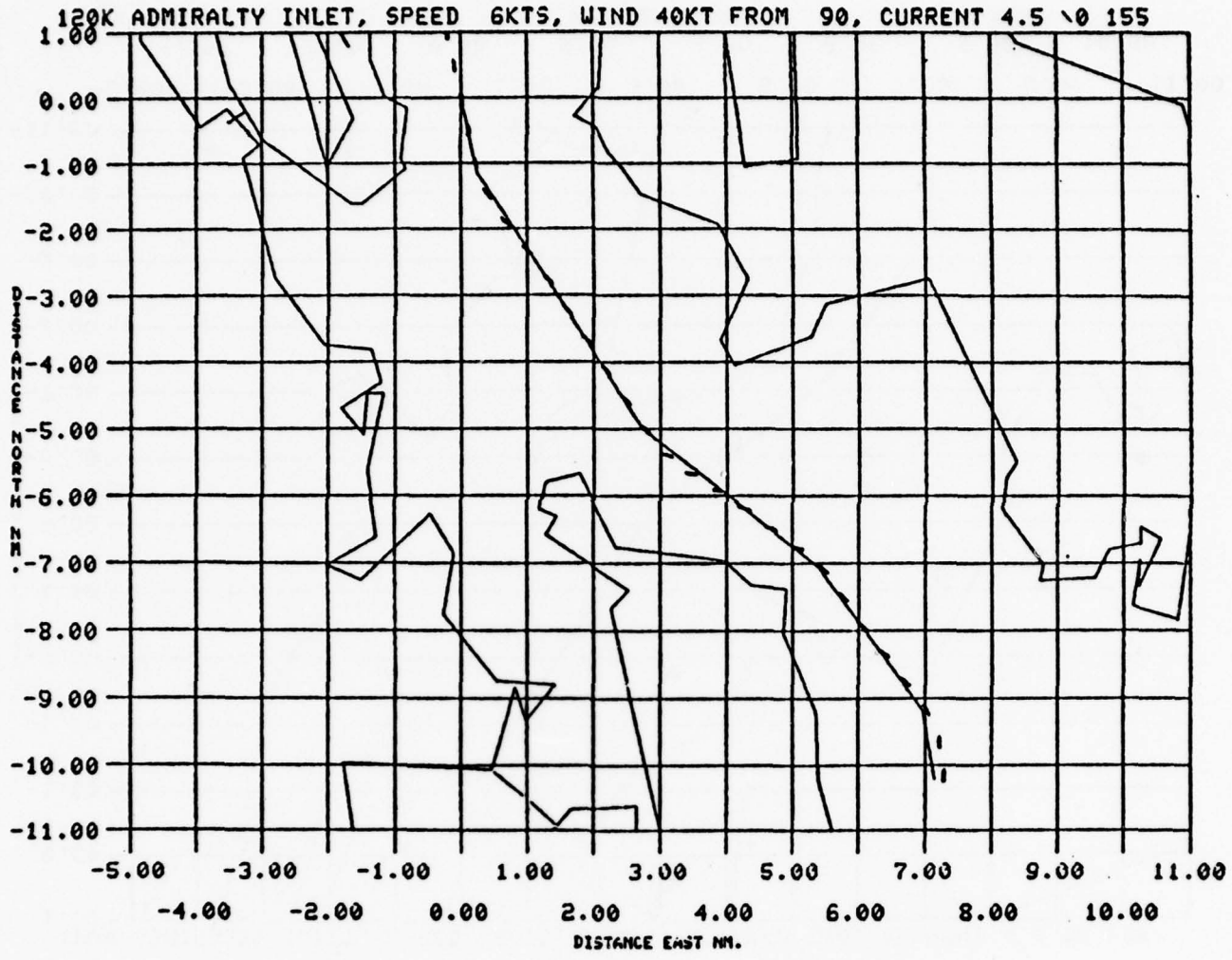

120K ADMIRALTY INLET, SPEED 4KTS, WIND 40KT FROM 270, CURRENT 1.0 TO 180
2.500
2.000
1.500
1.000
0.500
0.000
-0.500
-1.000
-1.500
-2.000
-2.500
-3.000
-3.500
DISTANCE NORTH NM.
-4.000 -3.000 -2.000 -1.000 0.000 1.000 2.000 3.000 4.000
-3.500 -2.500 -1.500 -0.500 0.500 1.500 2.500 3.500
DISTANCE EAST NM.

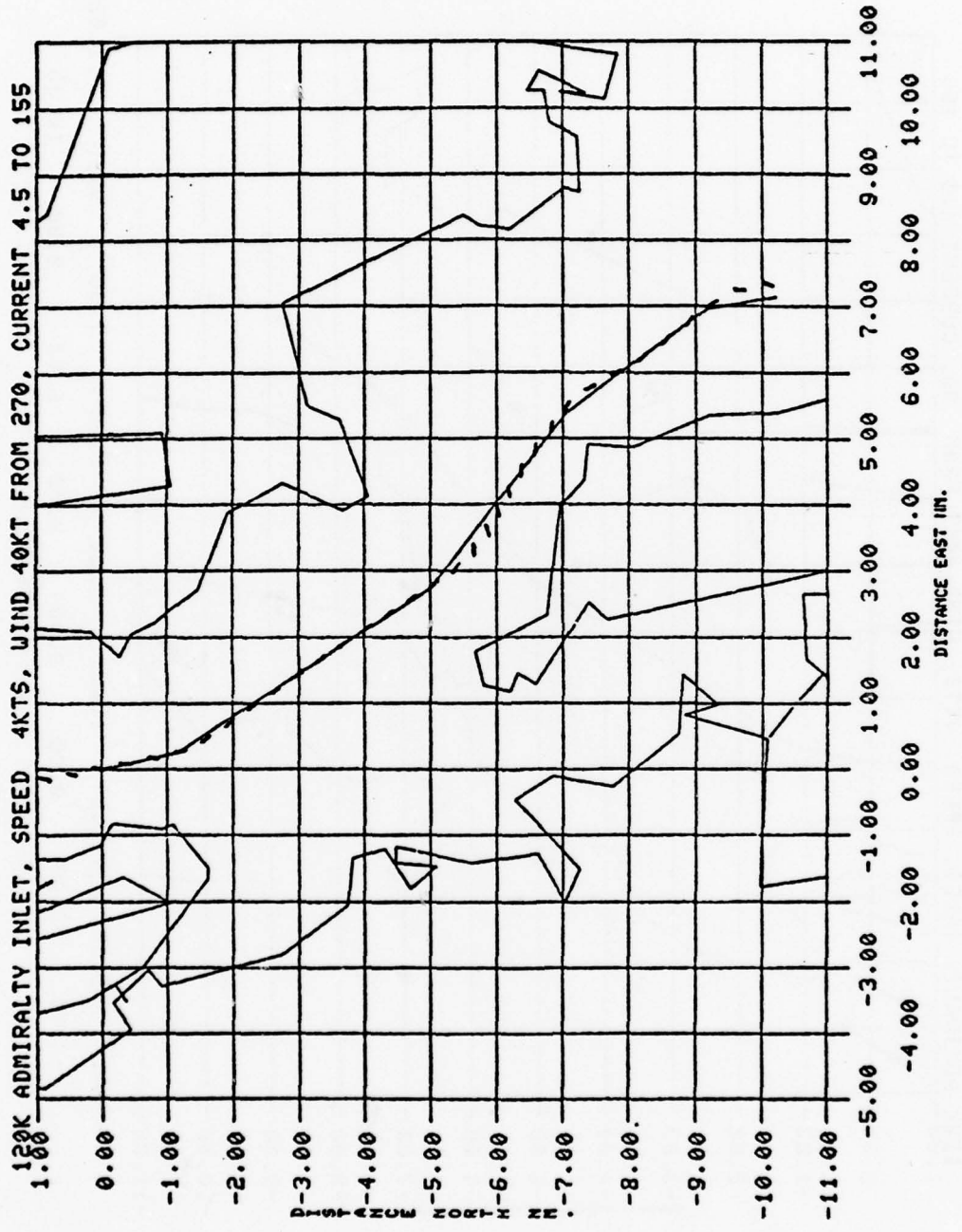

120K ADMIRALTY INLET, SPEED 4KTS, WIND 40KT FROM 90, CURRENT 1.0 TO 180
2.500
2.000
1.500
1.000
0.500
0.000
0.500
1.000
1.500
-2.000
-2.500
-3.000
-3.500
DISTANCE NORTH NM.
-4.000
-3.000
-2.000
-1.000
0.000
1.000
2.000
3.000
4.000
-3.500
-2.500
-1.500
-0.500
0.500
1.500
2.500
3.500
DISTANCE EAST NM.

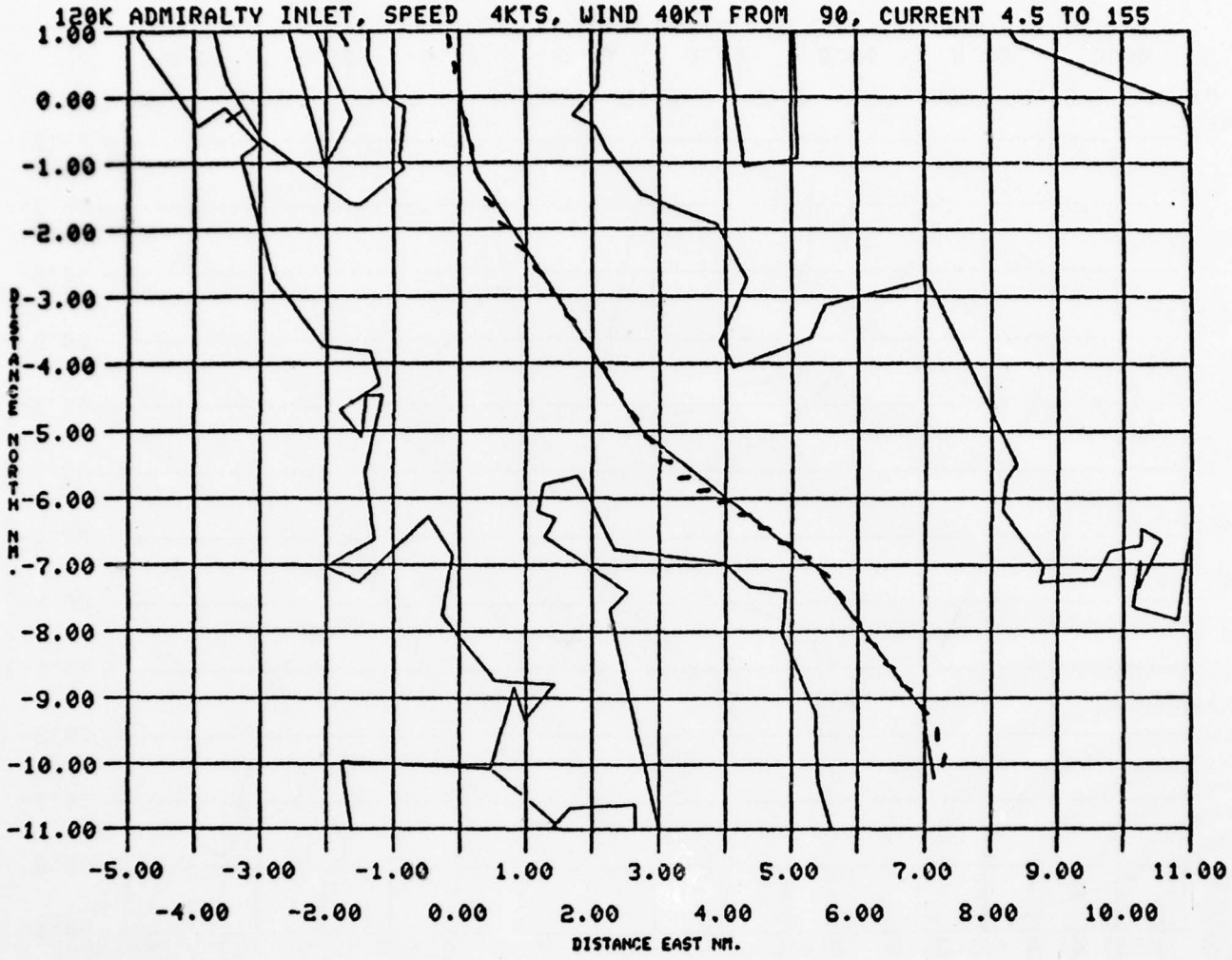

120K ADMIRALTY INLET, SPEED 8KTS, WIND 40KT FROM 270, CURRENT 4.5 TO 155
1.00
0.00
-1.00
-2.00
-3.00
-4.00
-5.00
-6.00
-7.00
-8.00
-9.00
-10.00
-11.00
DISTANCE NORTH NM.
-5.00
-3.00
-1.00
1.00
3.00
5.00
7.00
9.00
11.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
DISTANCE EAST NM.

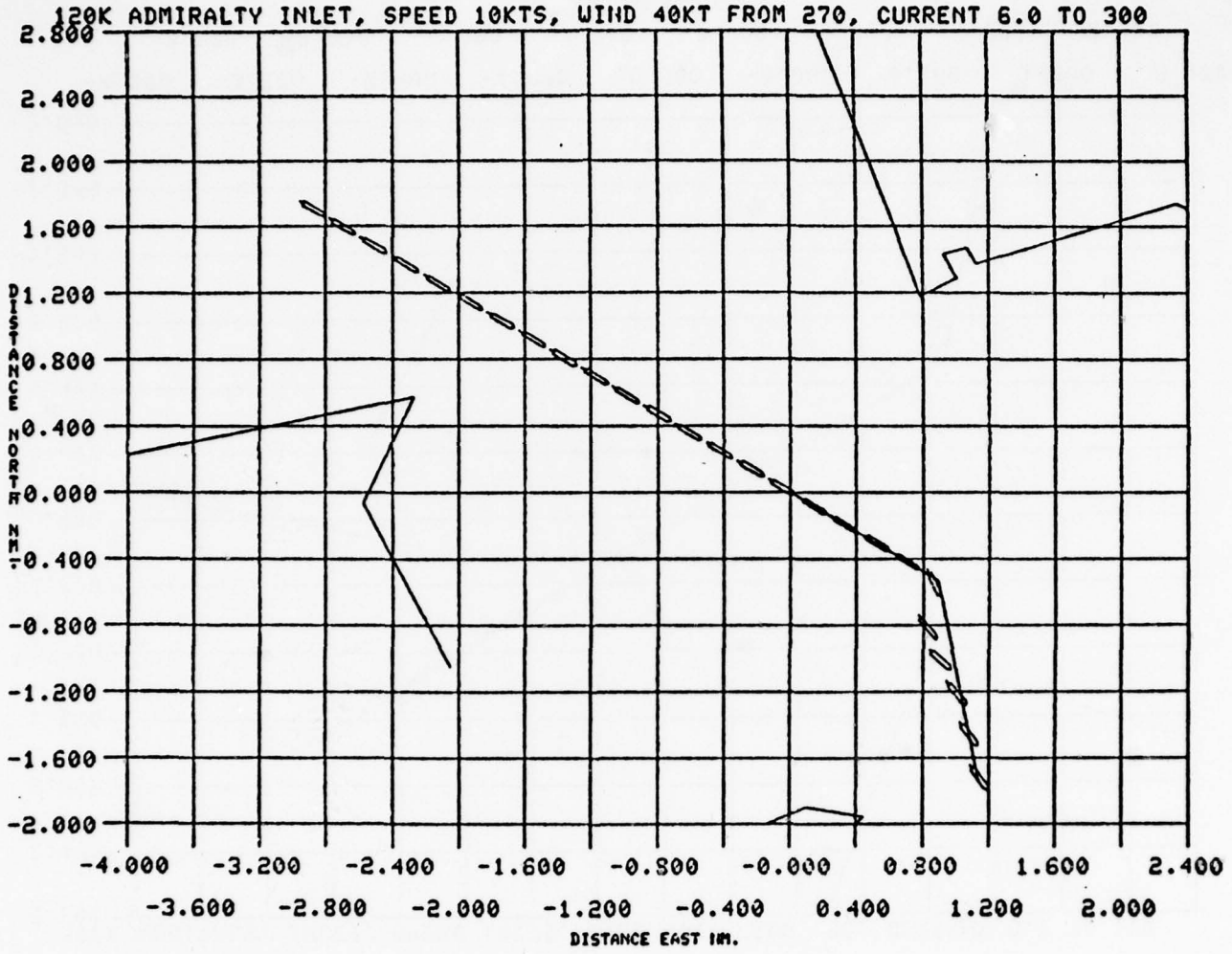

120K ADMIRALTY INLET, SPEED 8KTS, WIND 40KT FROM 90, CURRENT 4.5 TO 155
1.00
0.00
-1.00
-2.00
-3.00
-4.00
-5.00
-6.00
-7.00
-8.00
-9.00
-10.00
-11.00
DISTANCE NORTH NM.
-5.00
-3.00
-1.00
1.00
3.00
5.00
7.00
9.00
11.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
DISTANCE EAST NM.

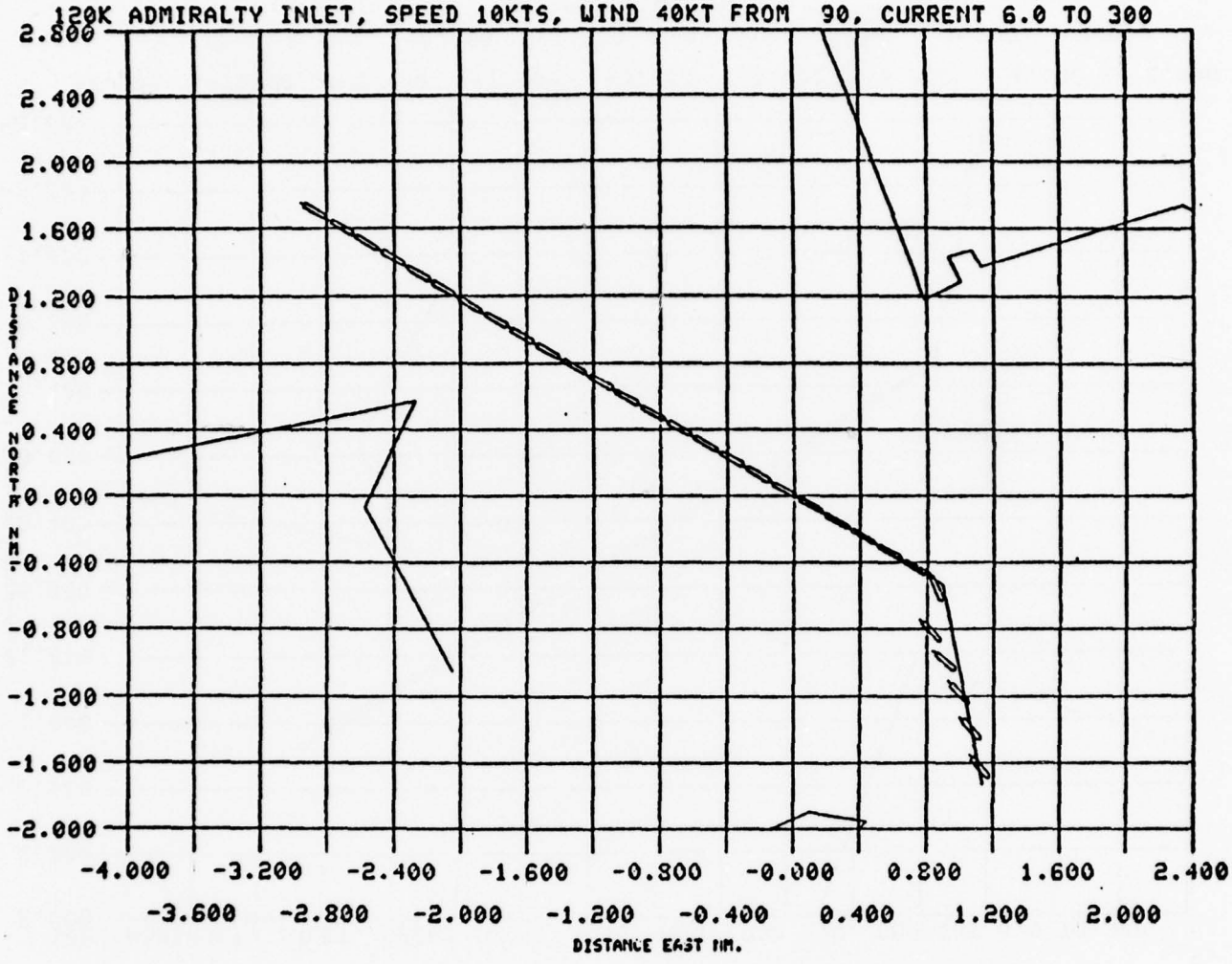

120K ADMIRALTY INLET, SPEED 6KTS, WIND 40KT FROM 270, CURRENT 4.5 TO 155
1.00
0.00
-1.00
-2.00
-3.00
-4.00
-5.00
-6.00
-7.00
-8.00
-9.00
-10.00
-11.00
DISTANCE NORTH NM.
-5.00
-3.00
-1.00
1.00
3.00
5.00
7.00
9.00
11.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
DISTANCE EAST NM.

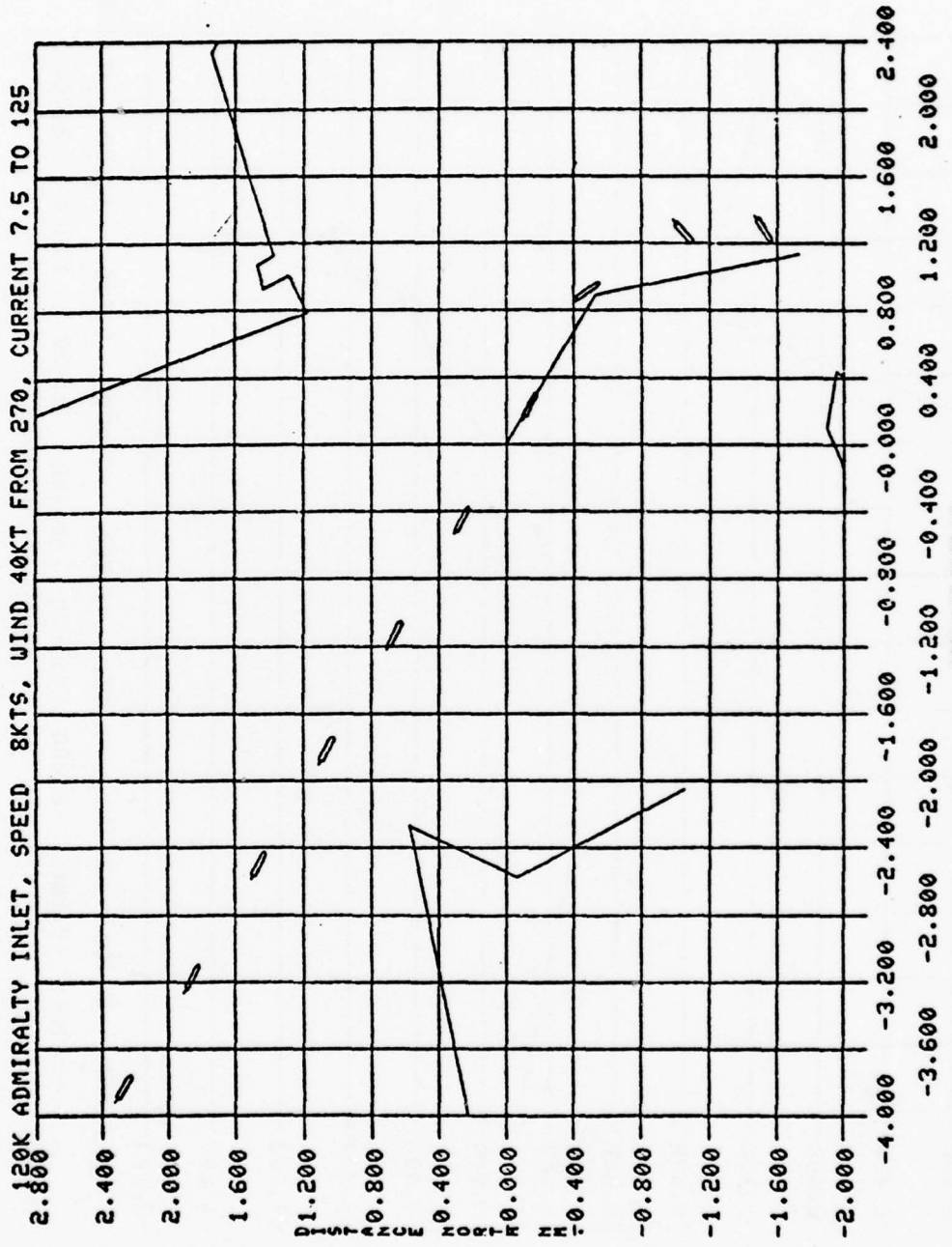

120K ADMIRALTY INLET, SPEED 6KTS, WIND 40KT FROM 90, CURRENT 4.5 \0 155
1.00
0.00
-1.00
-2.00
-3.00
-4.00
-5.00
-6.00
-7.00
-8.00
-9.00
-10.00
-11.00
DISTANCE NORTH NM.
-5.00
-3.00
-1.00
1.00
3.00
5.00
7.00
9.00
11.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
DISTANCE EAST NM.

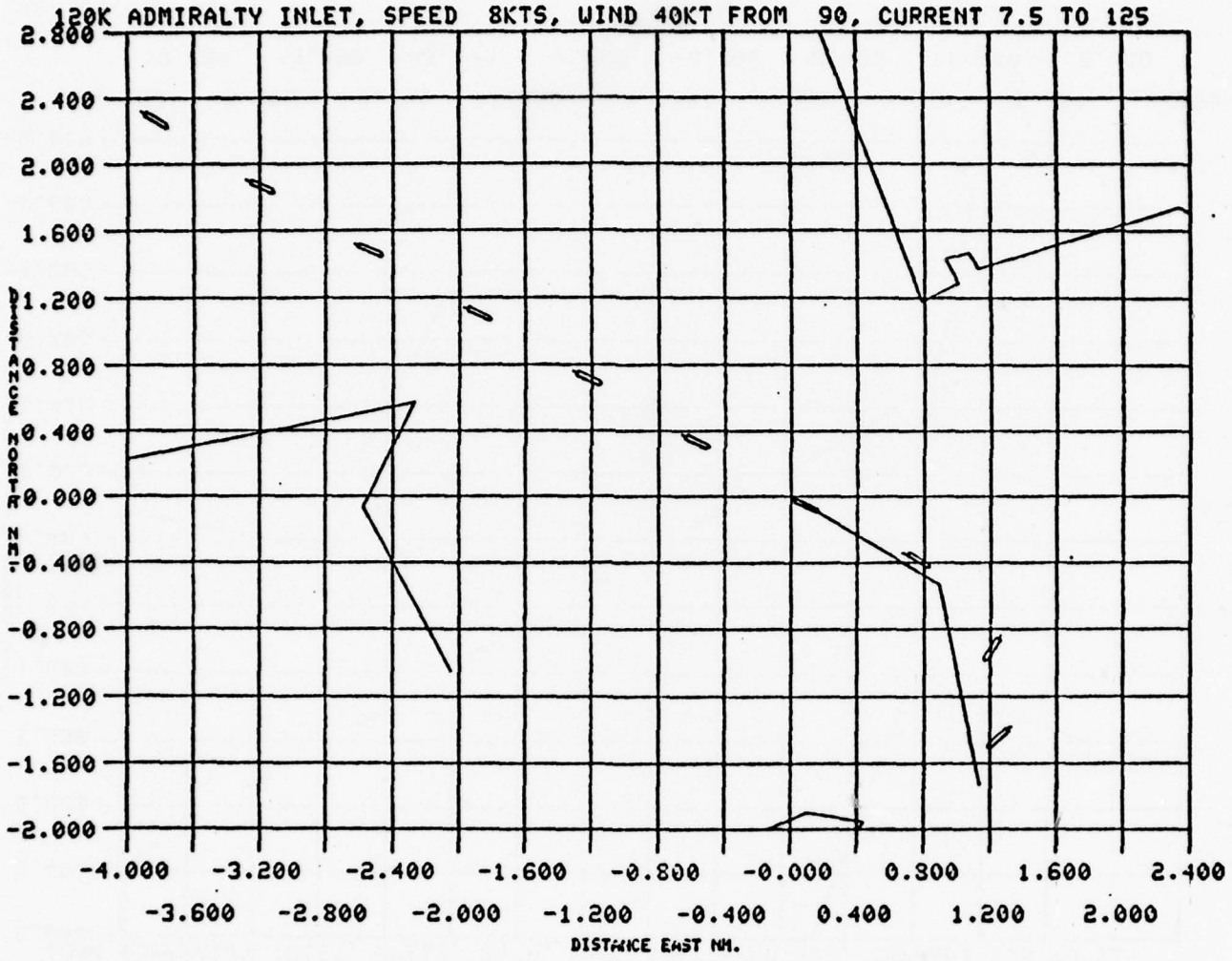

120K ADMIRALTY INLET, SPEED 4KTS, WIND 40KT FROM 270, CURRENT 4.5 TO 155
1.00
0.00
-1.00
-2.00
-3.00
-4.00
-5.00
-6.00
-7.00
-8.00
-9.00
-10.00
-11.00
DISTANCE NORTH NM.
-5.00
-4.00
-3.00
-2.00
-1.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
11.00
DISTANCE EAST NM.

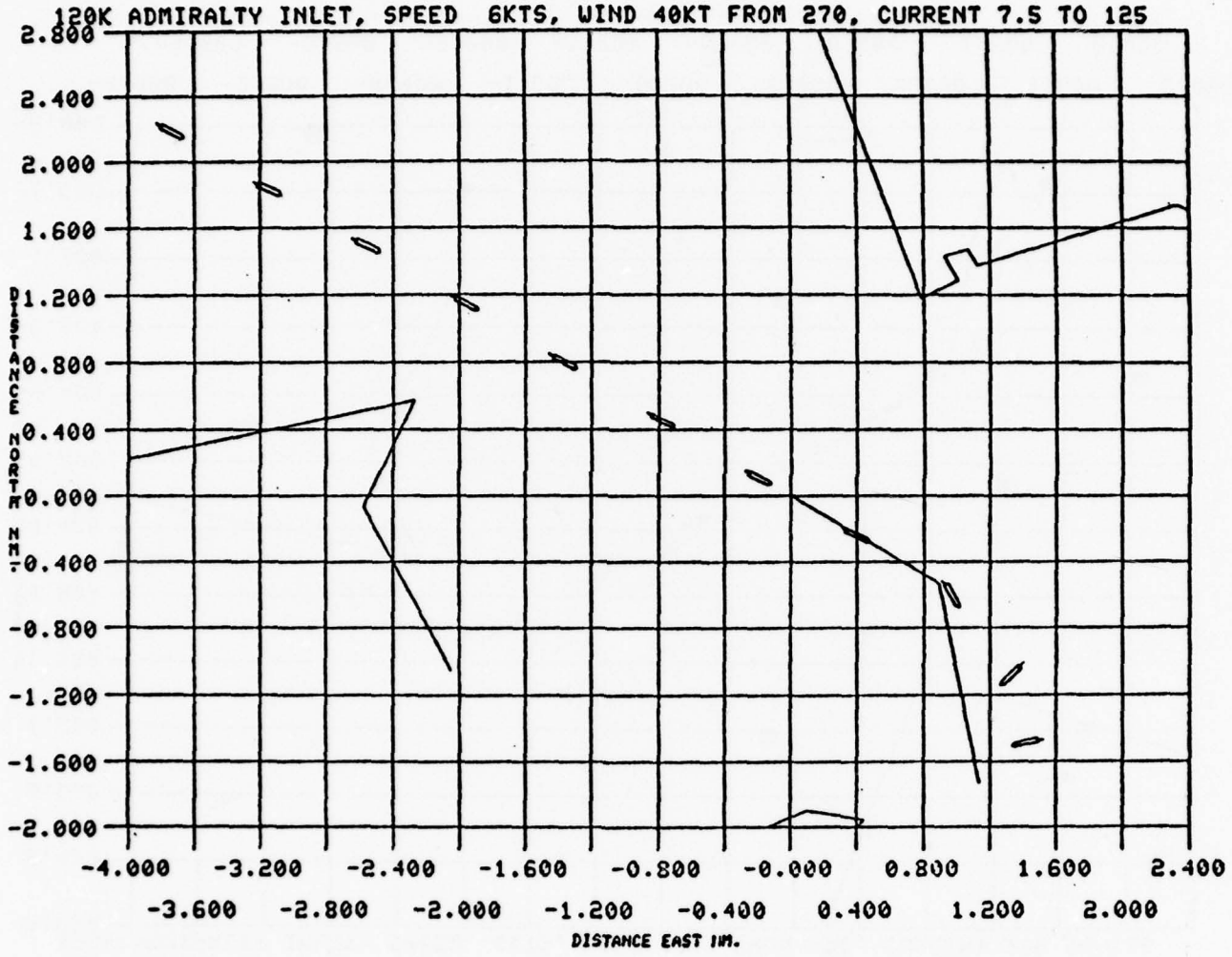

120K ADMIRALTY INLET, SPEED 4KTS, WIND 40KT FROM 90, CURRENT 4.5 TO 155
1.00
0.00
-1.00
-2.00
-3.00
-4.00
-5.00
-6.00
-7.00
-8.00
-9.00
-10.00
-11.00
DISTANCE NORTH NM.
-5.00
-3.00
-1.00
1.00
3.00
5.00
7.00
9.00
11.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
DISTANCE EAST NM.

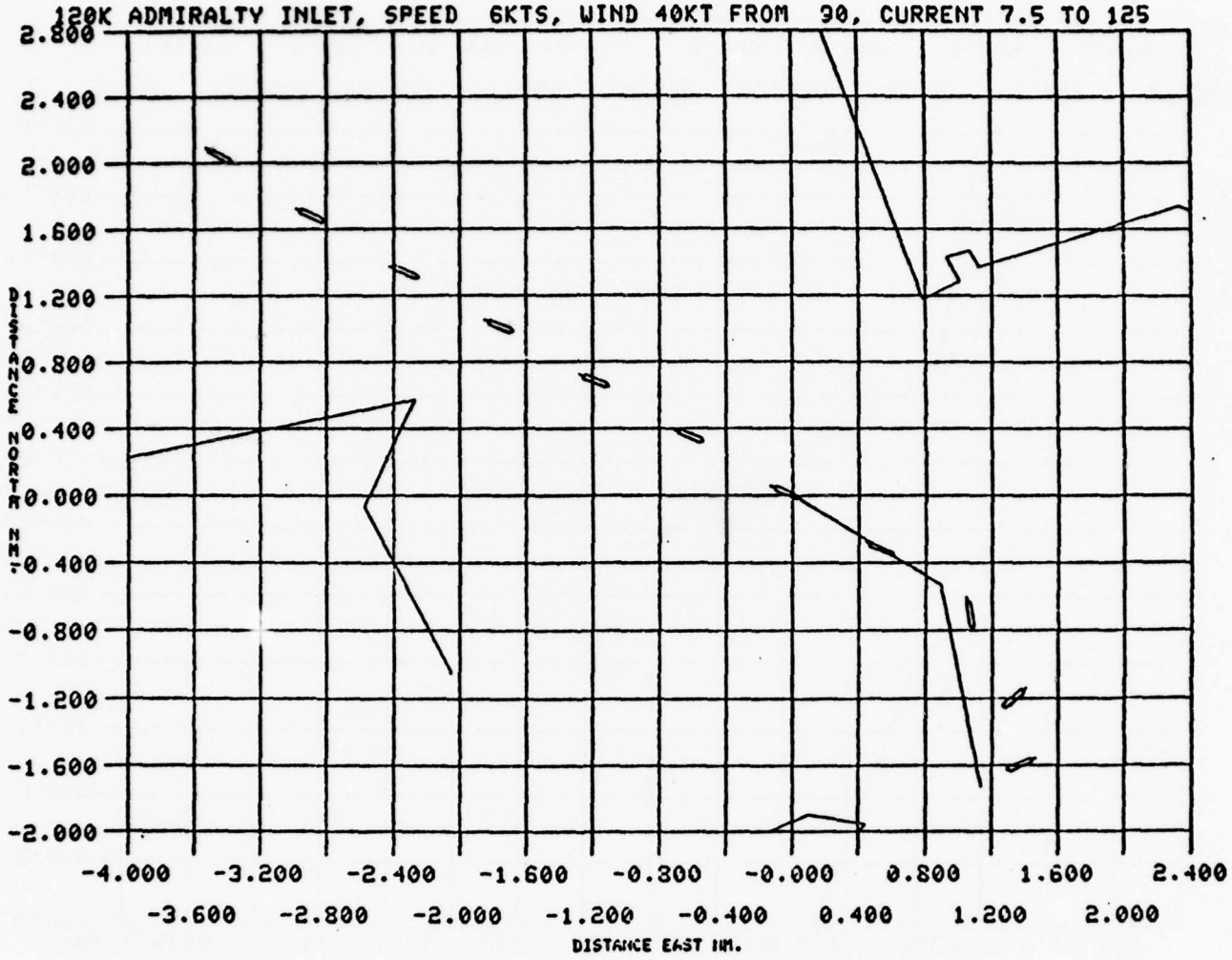

120K ADMIRALTY INLET, SPEED 10KTS, WIND 40KT FROM 270, CURRENT 6.0 TO 300
2.800
2.400
2.000
1.600
1.200
0.800
0.400
0.000
-0.400
-0.800
-1.200
-1.600
-2.000
DISTANCE NORTH NM.
-4.000
-3.200
-2.400
-1.600
-0.800
-0.000
0.800
1.600
2.400
-3.600
-2.800
-2.000
-1.200
-0.400
0.400
1.200
2.000
DISTANCE EAST NM.

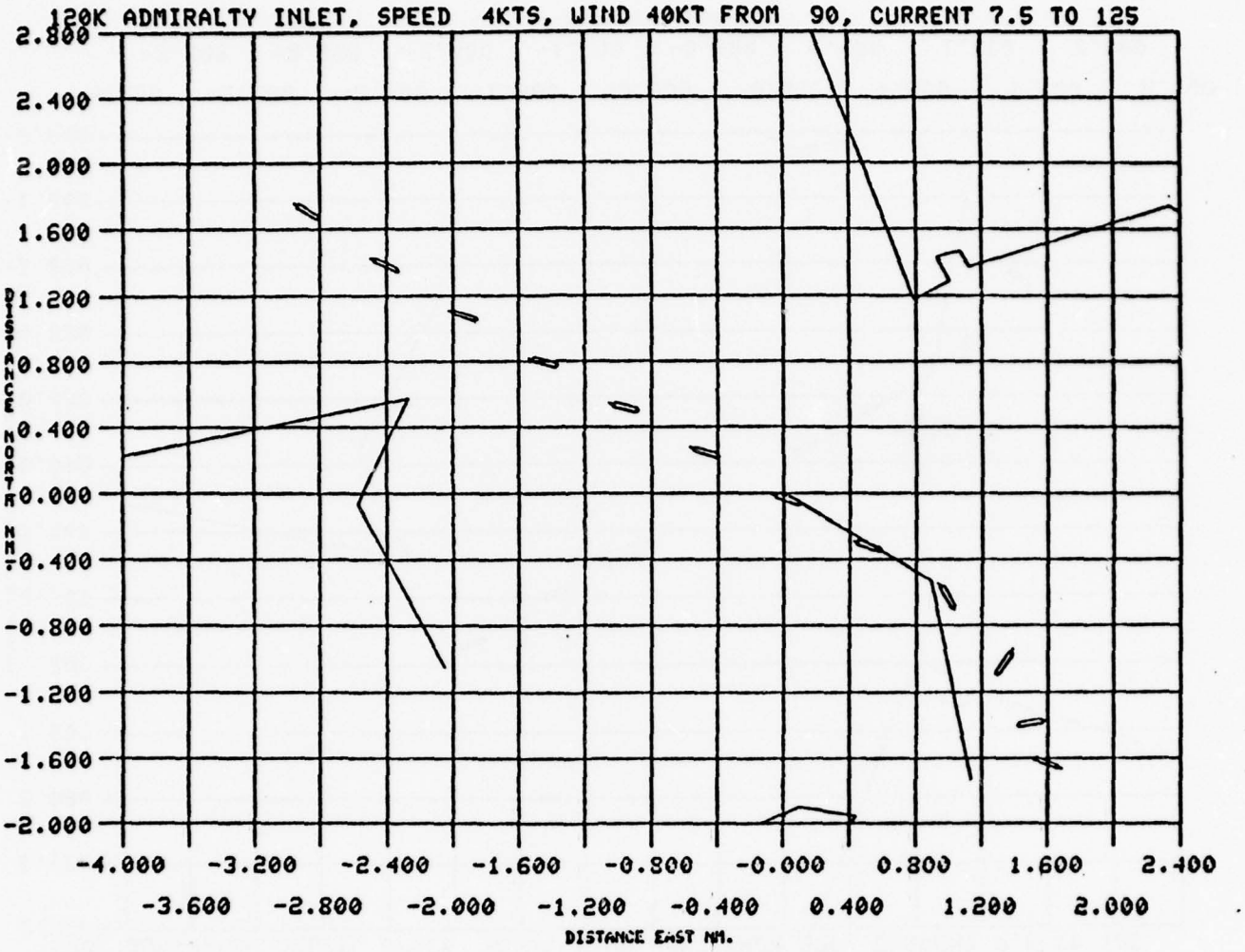

120K ADMIRALTY INLET, SPEED 10KTS, WIND 40KT FROM 90, CURRENT 6.0 TO 300
2.800
2.400
2.000
1.600
1.200
0.800
0.400
0.000
-0.400
-0.800
-1.200
-1.600
-2.000
DISTANCE NORTH NM.
-4.000
-3.200
-2.400
-1.600
-0.800
-0.000
0.800
1.600
2.400
-3.600
-2.800
-2.000
-1.200
-0.400
0.400
1.200
2.000
DISTANCE EAST NM.

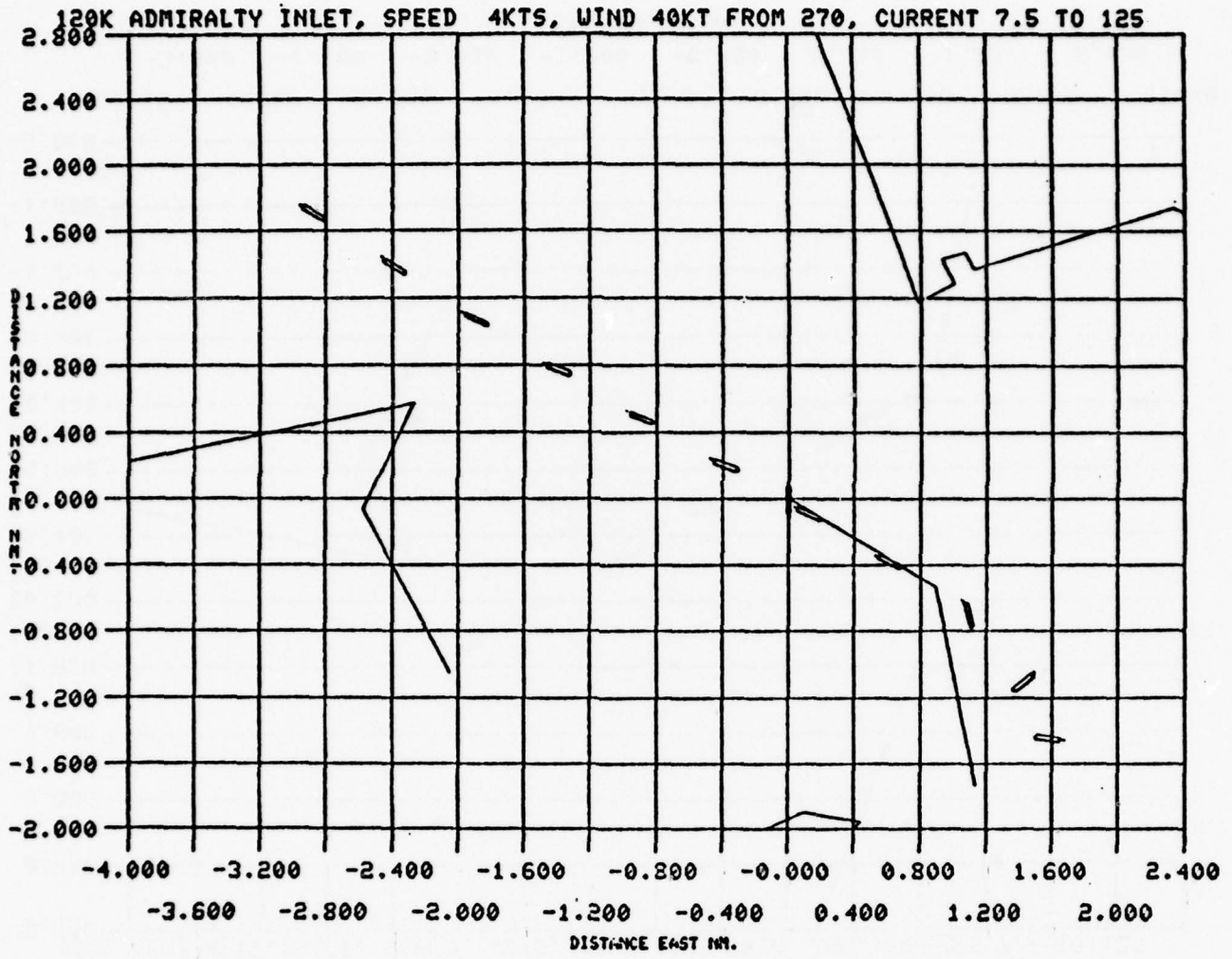

120K ADMIRALTY INLET, SPEED 8KTS, WIND 40KT FROM 270, CURRENT 7.5 TO 125
DISTANCE NORTH NM.
2.800
2.400
2.000
1.600
1.200
0.800
0.400
0.000
-0.400
-0.800
-1.200
-1.600
-2.000
DISTANCE EAST NM.
-4.000
-3.600
-3.200
-2.800
-2.400
-2.000
-1.600
-1.200
-0.800
-0.400
-0.000
0.400
0.800
1.200
1.600
2.000
2.400


120K ADMIRALTY INLET, SPEED 8KTS, WIND 40KT FROM 90, CURRENT 7.5 TO 125
2.800
2.400
2.000
1.600
1.200
0.800
0.400
0.000
-0.400
-0.800
-1.200
-1.600
-2.000
DISTANCE NORTH NM.
-4.000
-3.200
-2.400
-1.600
-0.800
-0.000
0.800
1.600
2.400
-3.600
-2.800
-2.000
-1.200
-0.400
0.400
1.200
2.000
DISTANCE EAST NM.


120K ADMIRALTY INLET, SPEED 6KTS, WIND 40KT FROM 270, CURRENT 7.5 TO 125
2.800
2.400
2.000
1.600
1.200
0.800
0.400
0.000
-0.400
-0.800
-1.200
-1.600
-2.000
DISTANCE NORTH NM.
-4.000
-3.200
-2.400
-1.600
-0.800
-0.000
0.800
1.600
2.400
-3.600
-2.800
-2.000
-1.200
-0.400
0.400
1.200
2.000
DISTANCE EAST NM.


120K ADMIRALTY INLET, SPEED 6KTS, WIND 40KT FROM 90, CURRENT 7.5 TO 125
2.800
2.400
2.000
1.600
1.200
0.800
0.400
0.000
0.400
-0.800
-1.200
-1.600
-2.000
DISTANCE NORTH NM.
-4.000
-3.200
-2.400
-1.600
-0.300
-0.000
0.800
1.600
2.400
-3.600
-2.800
-2.000
-1.200
-0.400
0.400
1.200
2.000
DISTANCE EAST NM.

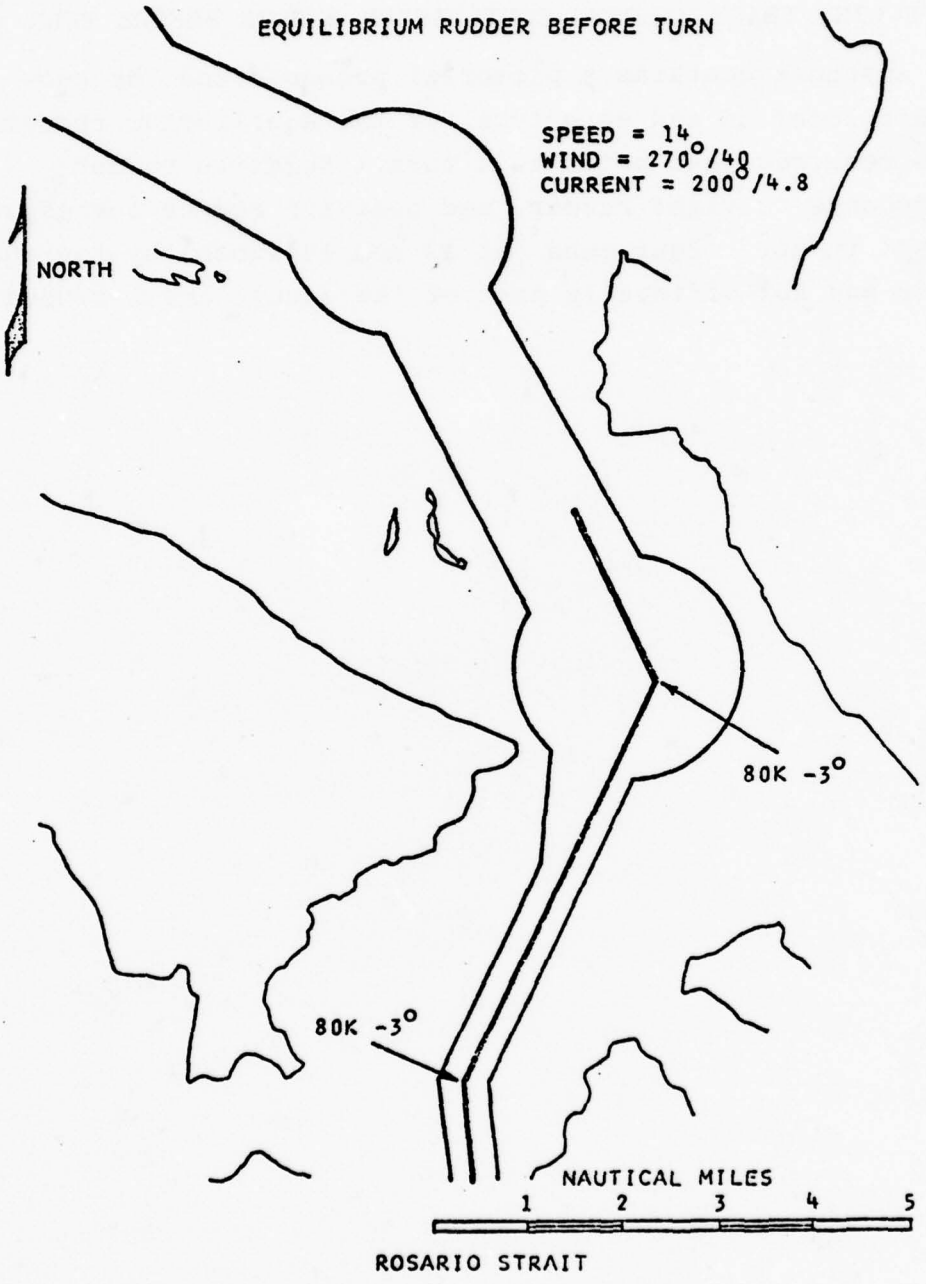

120K ADMIRALTY INLET, SPEED 4KTS, WIND 40KT FROM 90, CURRENT 7.5 TO 125
2.800
2.400
2.000
1.600
1.200
0.800
0.400
0.000
-0.400
-0.800
-1.200
-1.600
-2.000
DISTANCE NORTH NM.
-4.000
-3.200
-2.400
-1.600
-0.800
-0.000
0.800
1.600
2.400
-3.600
-2.800
-2.000
-1.200
-0.400
0.400
1.200
2.000
DISTANCE EAST NM.

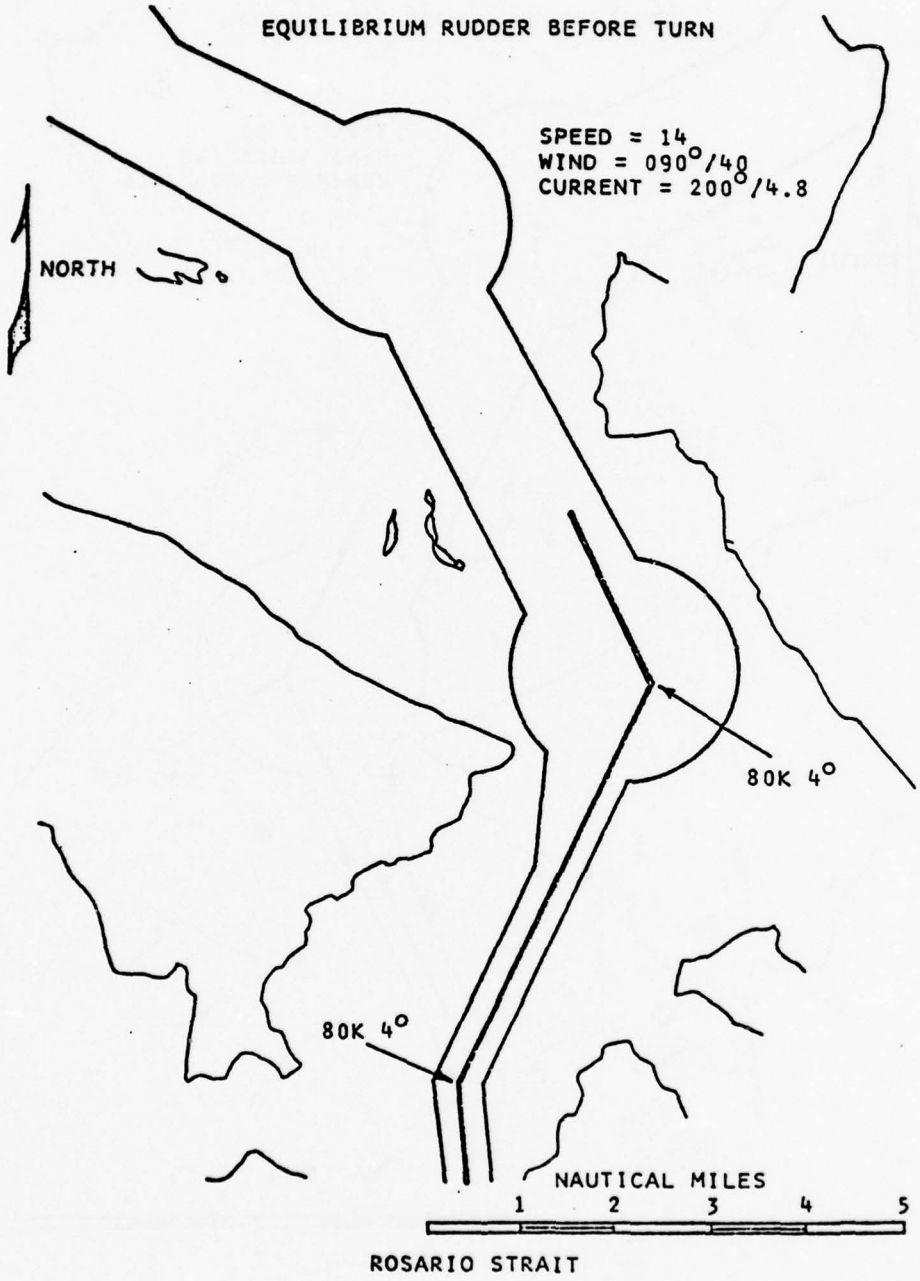

120K ADMIRALTY INLET, SPEED 4KTS, WIND 40KT FROM 270, CURRENT 7.5 TO 125
2.800
2.400
2.000
1.600
1.200
0.800
0.400
0.000
-0.400
-0.800
-1.200
-1.600
-2.000
DISTANCE NORTH NM.
-4.000
-3.200
-2.400
-1.600
-0.800
-0.000
0.800
1.600
2.400
-3.600
-2.800
-2.000
-1.200
-0.400
0.400
1.200
2.000
DISTANCE EAST NM.

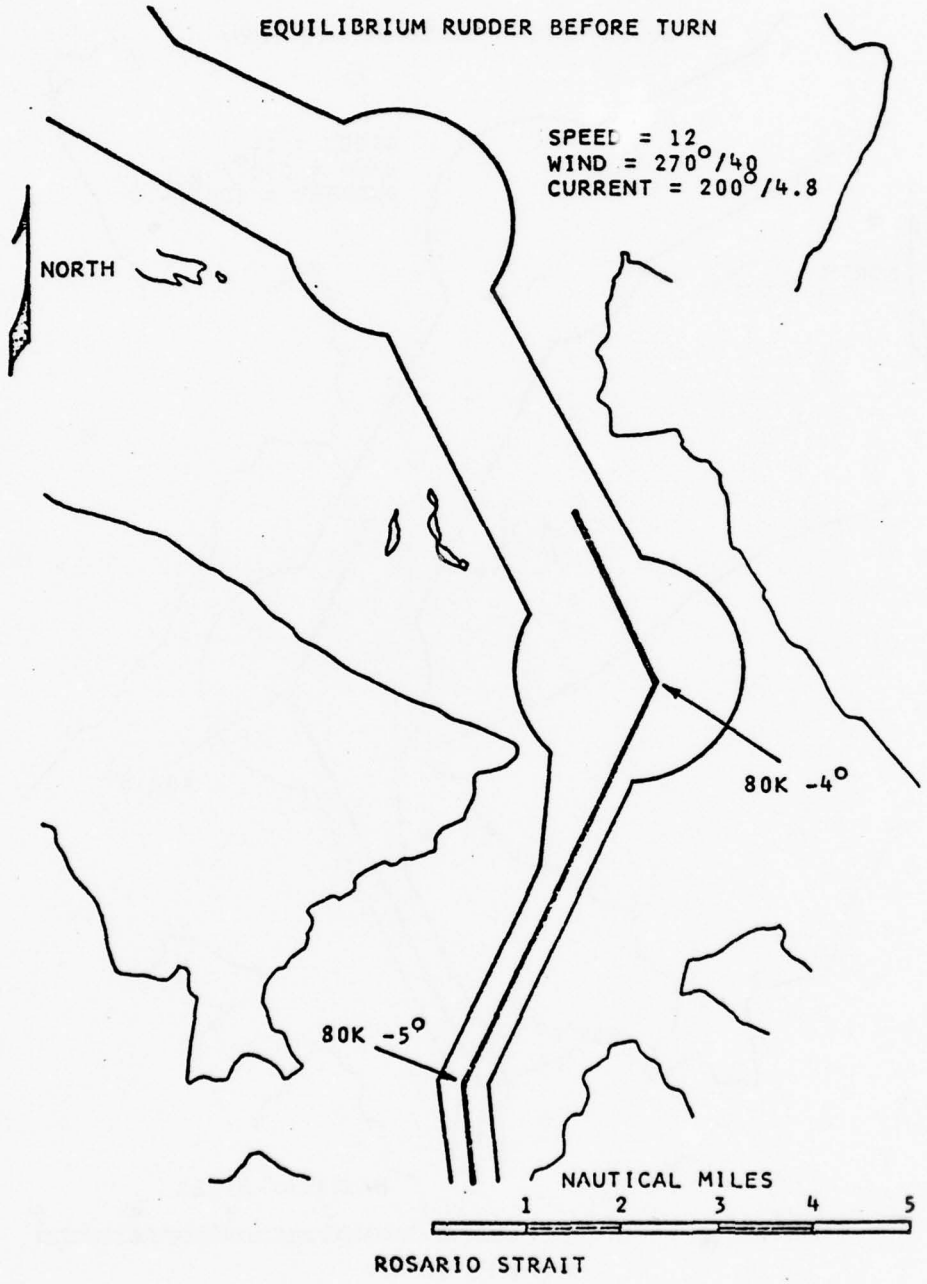
APPENDIX H

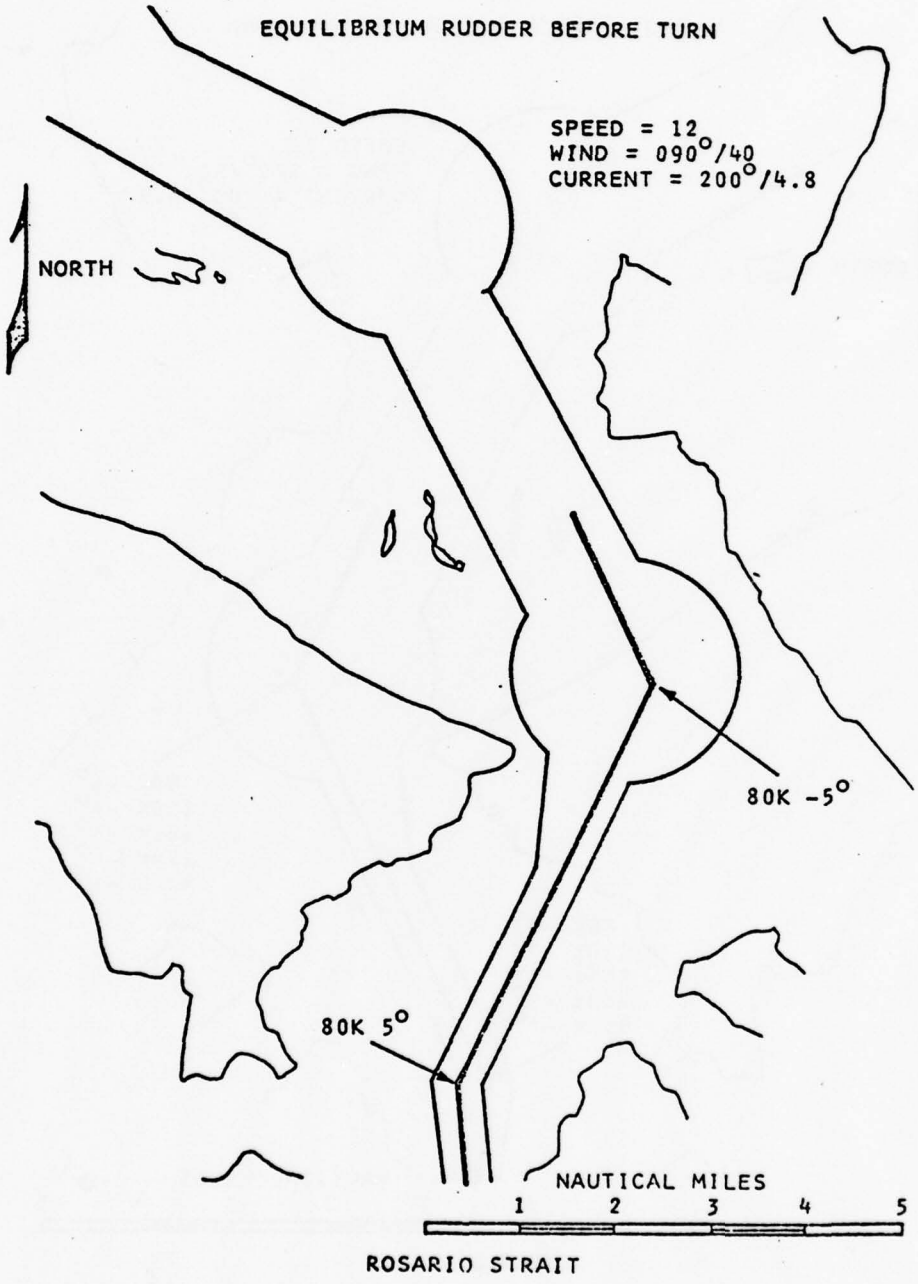
OFF-LINE TRACK KEEPING EQUILIBRIUM RUDDER BEFORE TURN

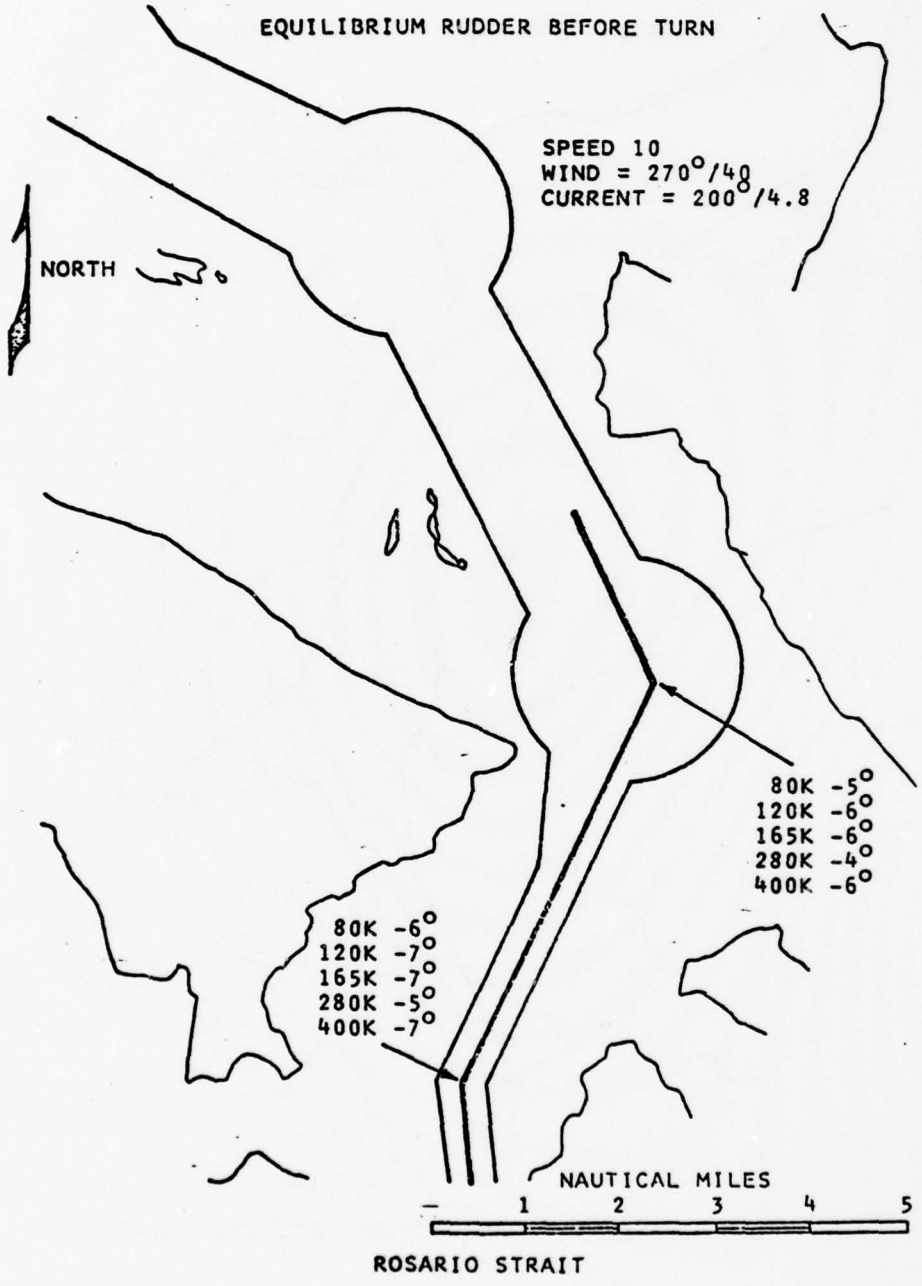
This appendix contains a pictorial presentation, by geographic location and ship type, of the equilibrium rudder angle required just prior to a turn. Negative rudder corresponds to right rudder, and positive rudder corresponds to left rudder. Four runs (at 12 and 14 knots) by the 80K tanker and not officially part of the study, are included.

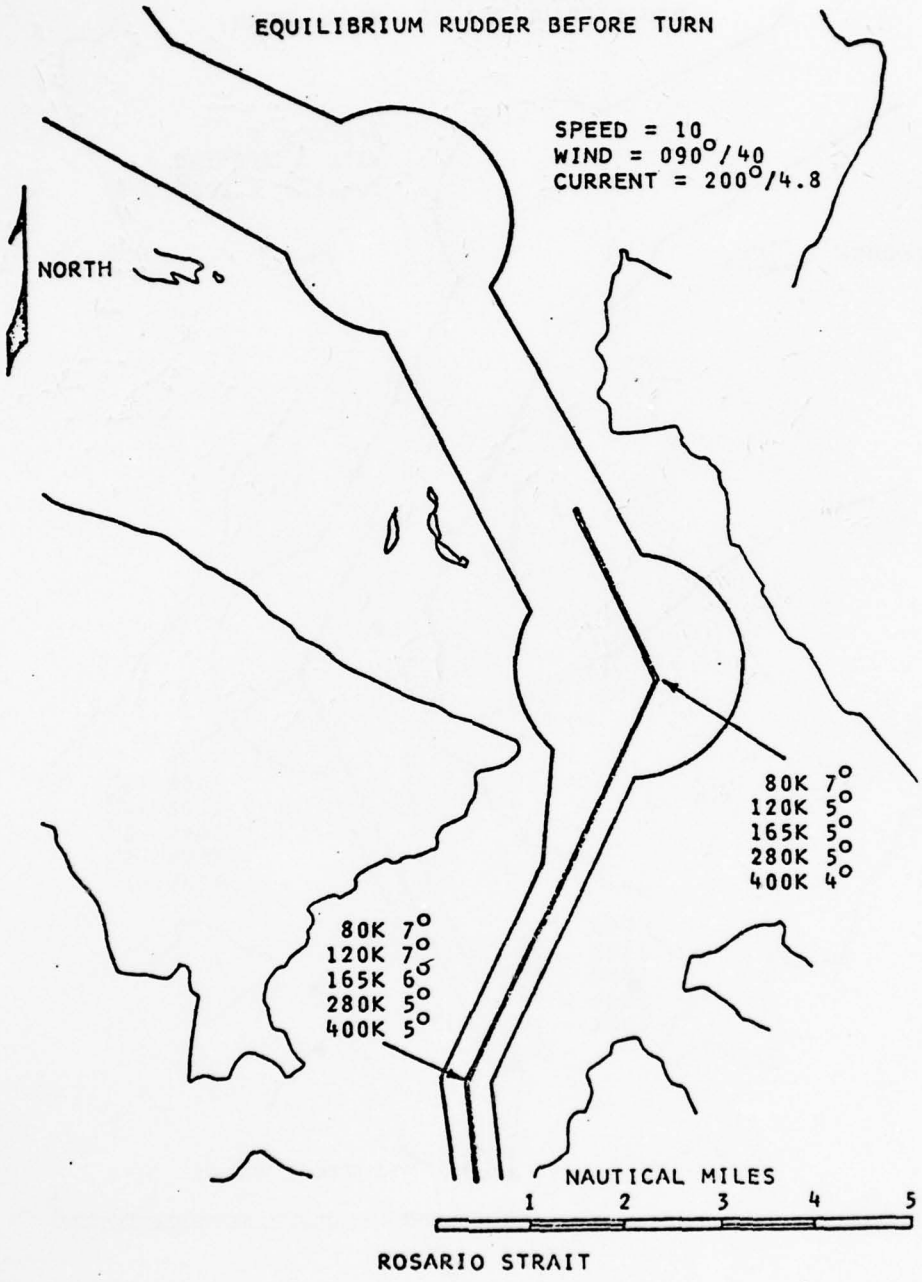

EQUILIBRIUM RUDDER BEFORE TURN
SPEED = 14
WIND = 270°/40
CURRENT = 200°/4.8
NORTH
80K -3°
80K -3°
NAUTICAL MILES
1 2 3 4 5
ROSARIO STRAIT

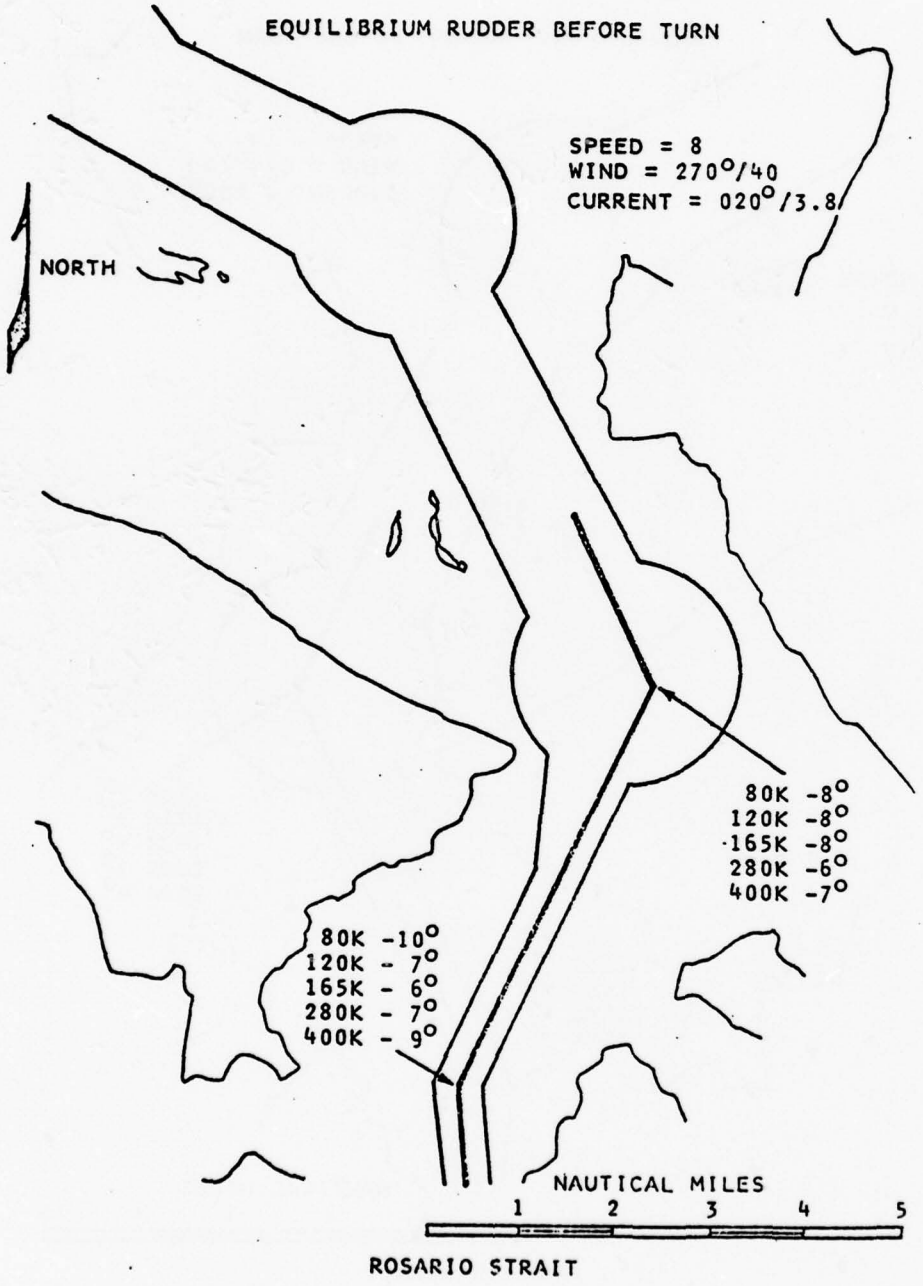

EQUILIBRIUM RUDDER BEFORE TURN
SPEED = 14
WIND = 090°/40
CURRENT = 200°/4.8
NORTH
80K 4°
80K 4°
NAUTICAL MILES
1 2 3 4 5
ROSARIO STRAIT

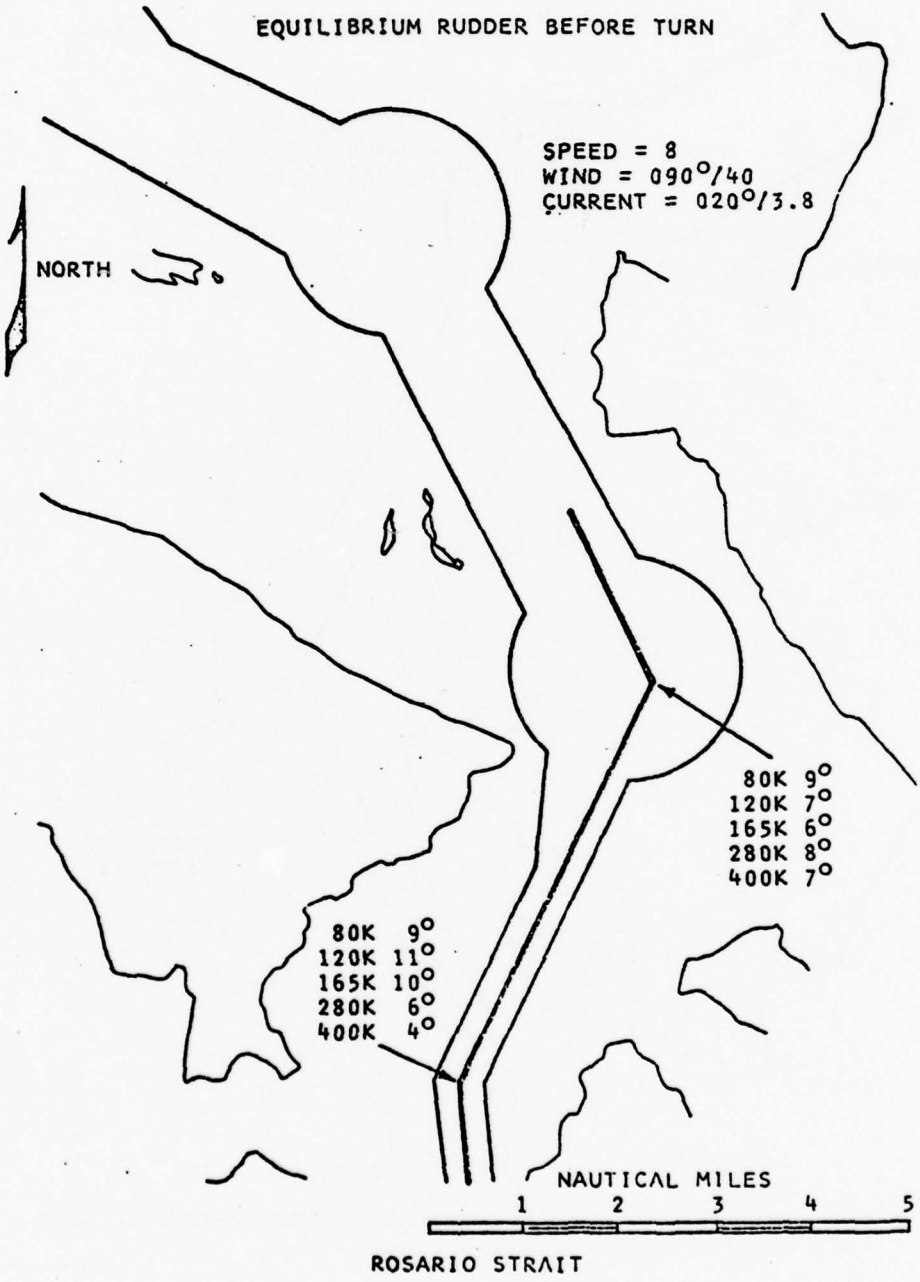

EQUILIBRIUM RUDDER BEFORE TURN
SPEED = 12
WIND = 270°/40
CURRENT = 200°/4.8
NORTH
80K -4°
80K -5°
NAUTICAL MILES
1 2 3 4 5
ROSARIO STRAIT

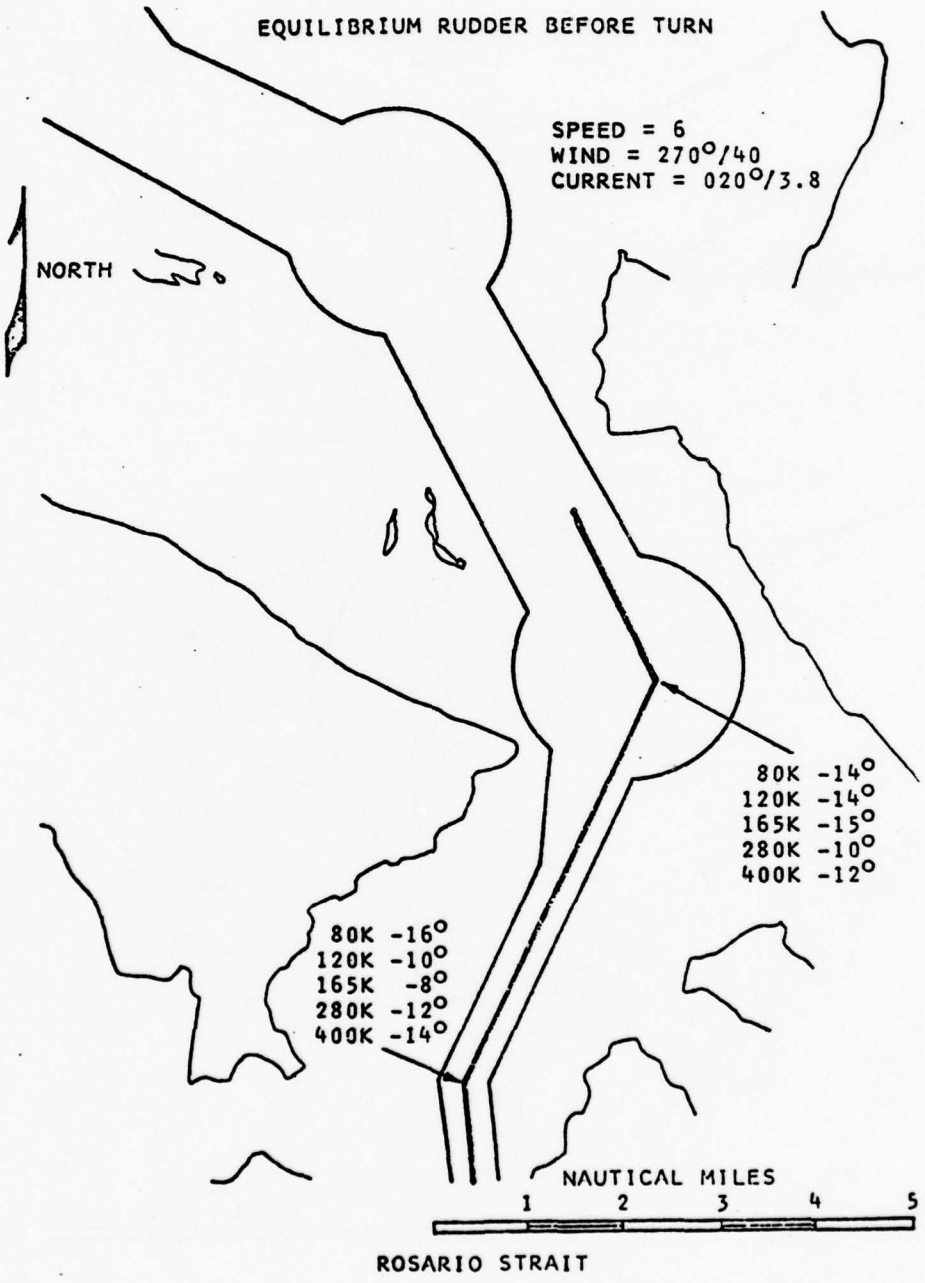

EQUILIBRIUM RUDDER BEFORE TURN
SPEED = 12
WIND = 090°/40
CURRENT = 200°/4.8
NORTH
80K -5°
80K 5°
NAUTICAL MILES
1 2 3 4 5
ROSARIO STRAIT

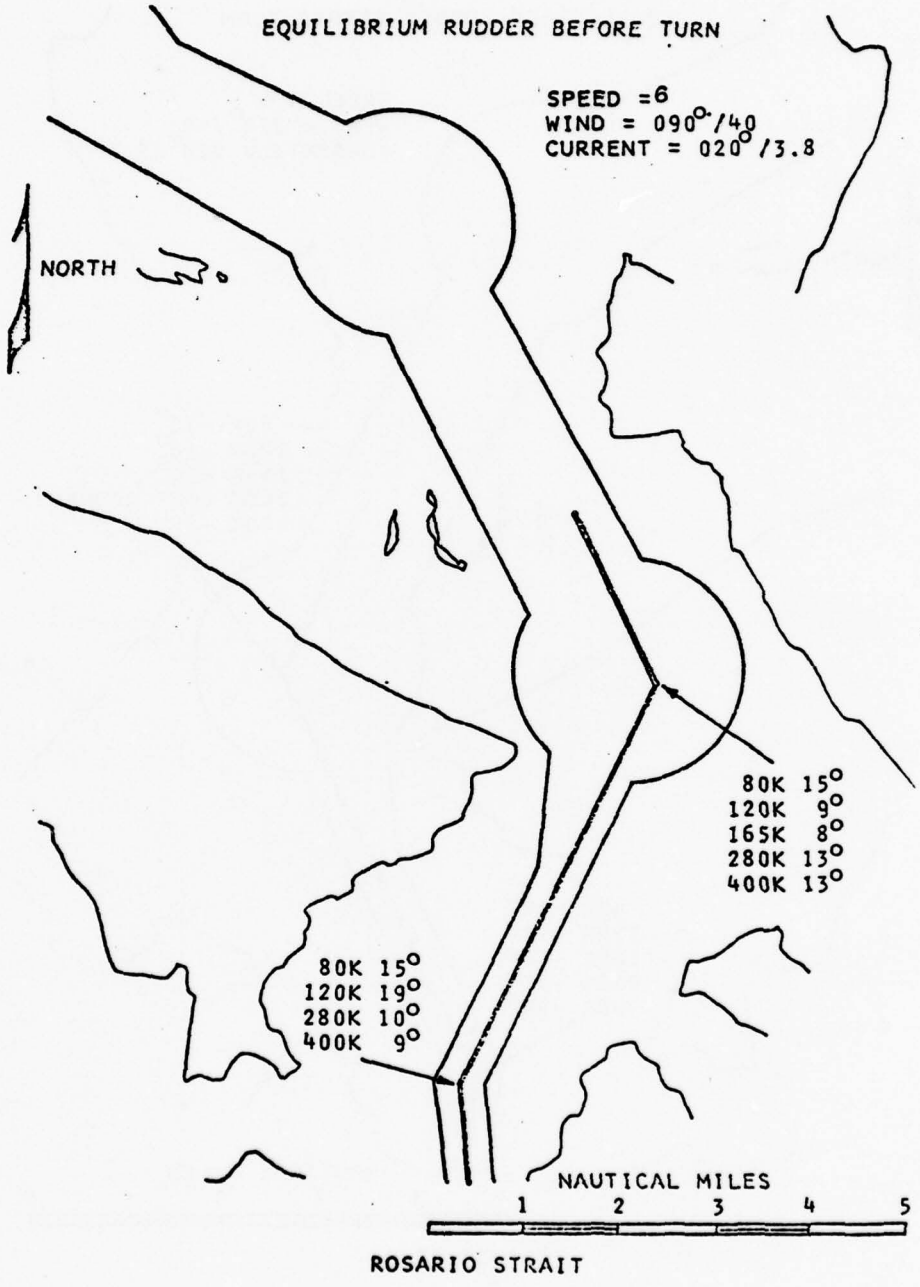

EQUILIBRIUM RUDDER BEFORE TURN
SPEED 10
WIND = 270°/40
CURRENT = 200°/4.8
NORTH
80K -5°
120K -6°
165K -6°
280K -4°
400K -6°
80K -6°
120K -7°
165K -7°
280K -5°
400K -7°
NAUTICAL MILES
1
2
3
4
5
ROSARIO STRAIT

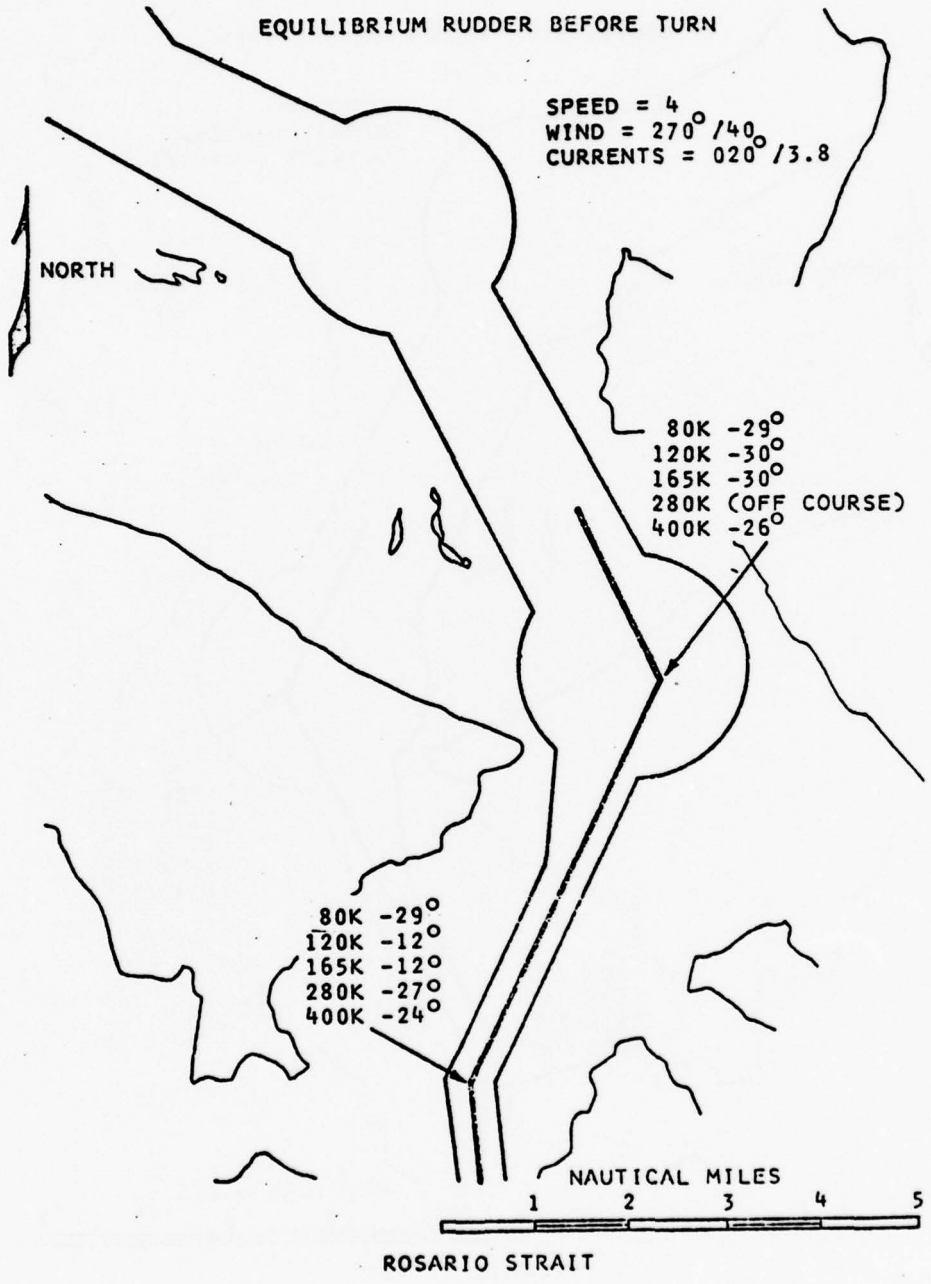

EQUILIBRIUM RUDDER BEFORE TURN
SPEED = 10
WIND = 090°/40
CURRENT = 200°/4.8
NORTH
80K 7°
120K 5°
165K 5°
280K 5°
400K 4°
80K 7°
120K 7°
165K 6°
280K 5°
400K 5°
NAUTICAL MILES
1 2 3 4 5
ROSARIO STRAIT

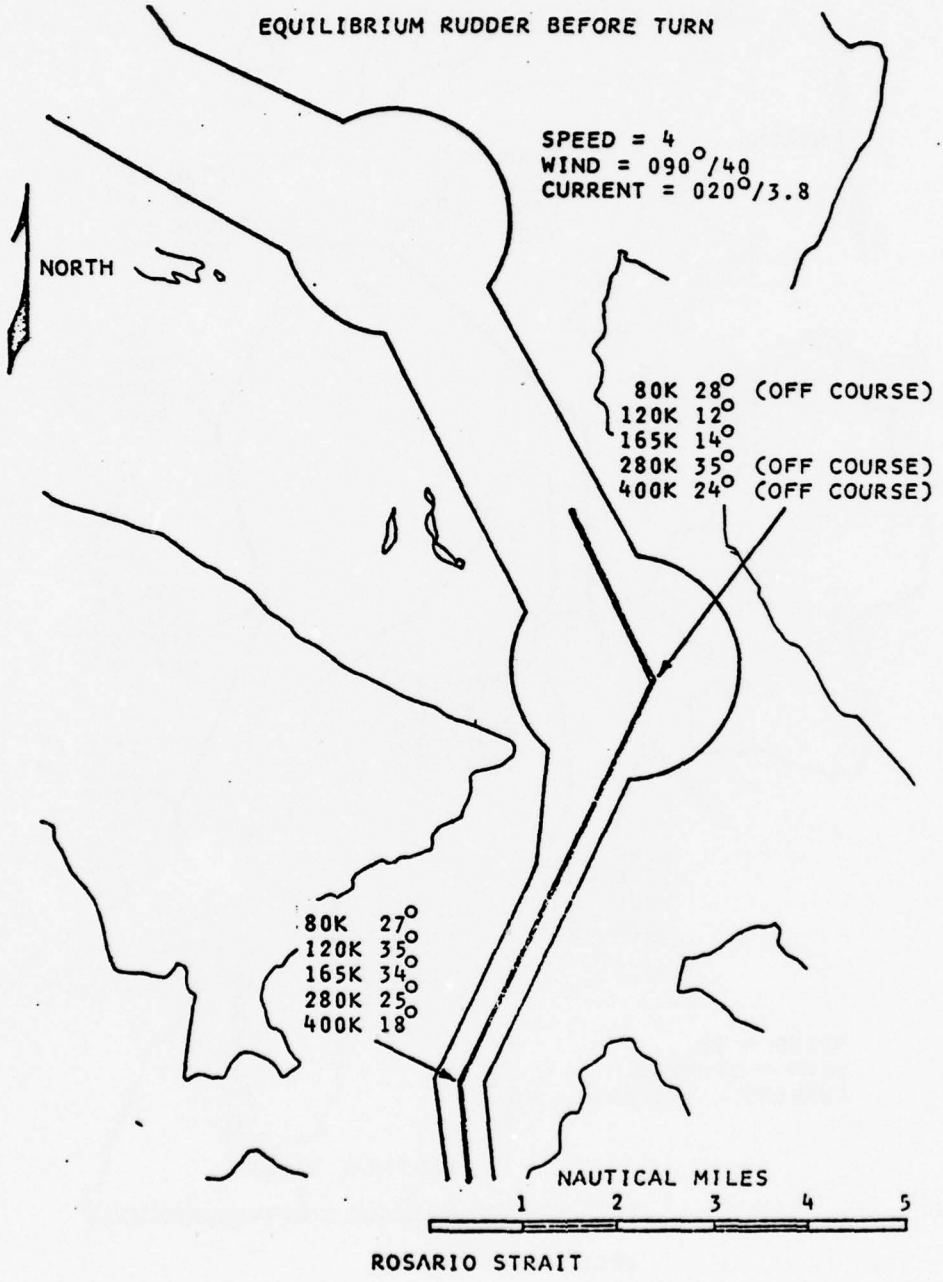

EQUILIBRIUM RUDDER BEFORE TURN
SPEED = 8
WIND = 270°/40
CURRENT = 020°/3.8
NORTH
80K -8°
120K -8°
165K -8°
280K -6°
400K -7°
80K -10°
120K - 7°
165K - 6°
280K - 7°
400K - 9°
NAUTICAL MILES
1 2 3 4 5
ROSARIO STRAIT

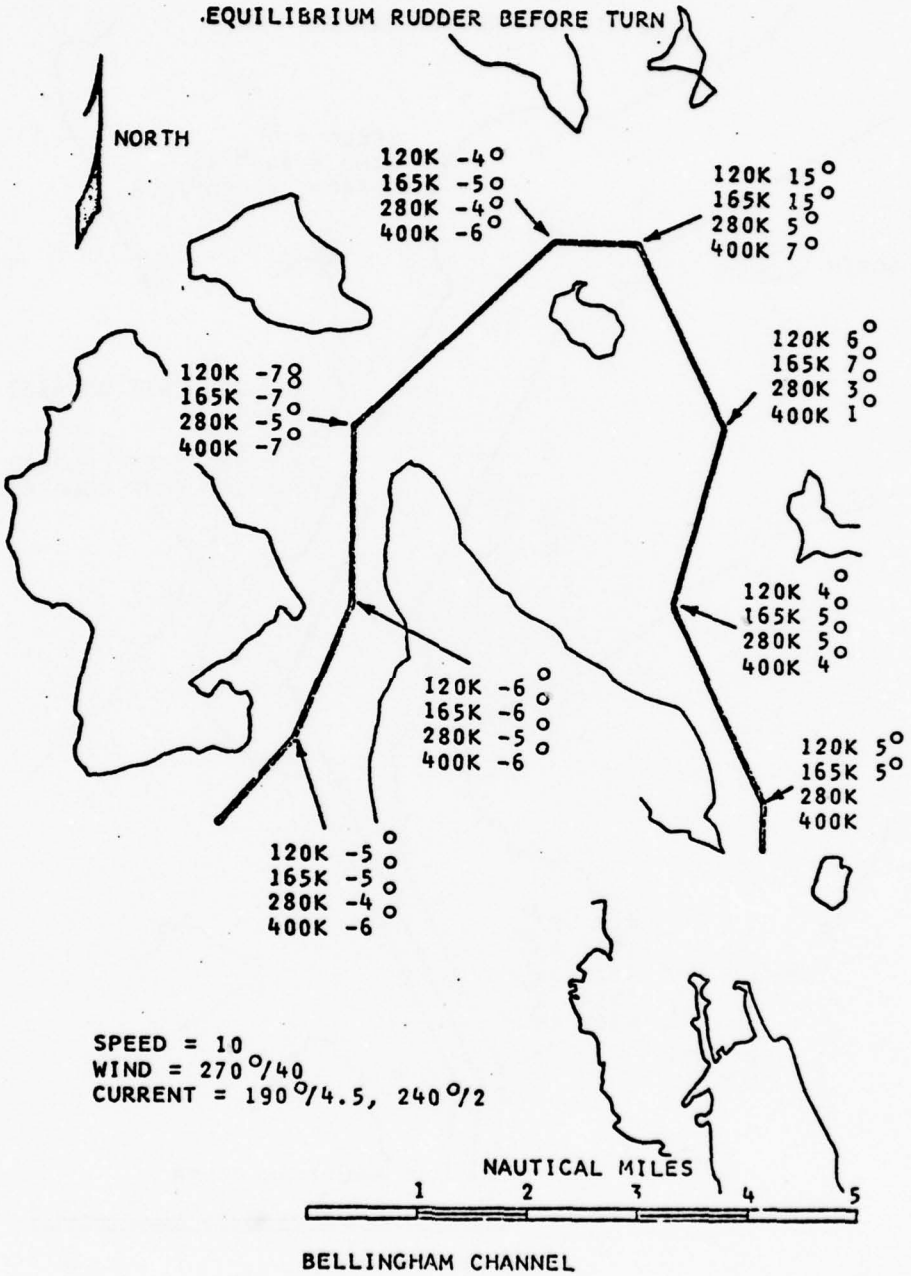

EQUILIBRIUM RUDDER BEFORE TURN
SPEED = 8
WIND = 090°/40
CURRENT = 020°/3.8
NORTH
80K 9°
120K 7°
165K 6°
280K 8°
400K 7°
80K 9°
120K 11°
165K 10°
280K 6°
400K 4°
NAUTICAL MILES
1 2 3 4 5
ROSARIO STRAIT


EQUILIBRIUM RUDDER BEFORE TURN
SPEED = 6
WIND = 270°/40
CURRENT = 020°/3.8
NORTH
80K -14°
120K -14°
165K -15°
280K -10°
400K -12°
80K -16°
120K -10°
165K -8°
280K -12°
400K -14°
NAUTICAL MILES
1 2 3 4 5
ROSARIO STRAIT

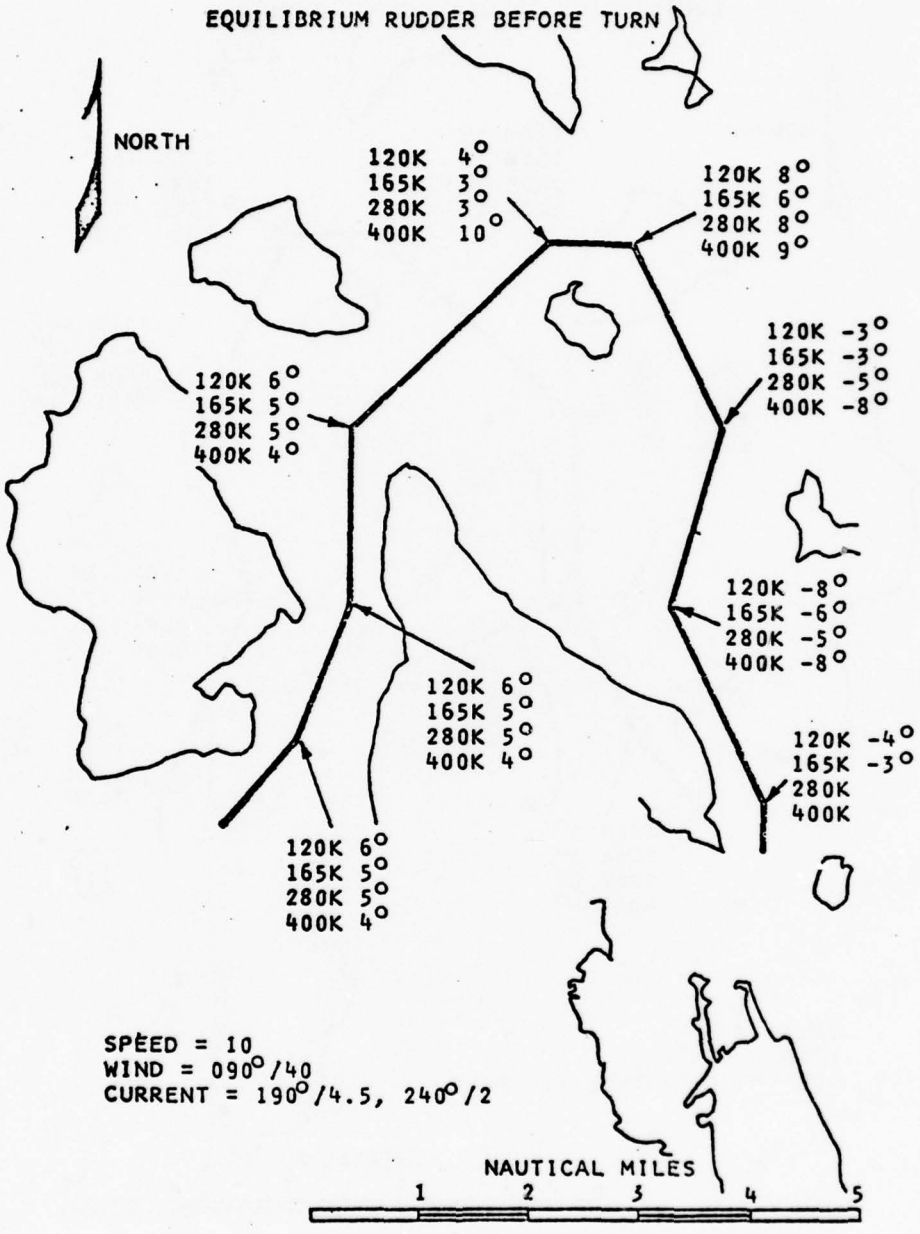

EQUILIBRIUM RUDDER BEFORE TURN
SPEED =6
WIND = 090°/40
CURRENT = 020°/3.8
NORTH
80K 15°
120K 9°
165K 8°
280K 13°
400K 13°
80K 15°
120K 19°
280K 10°
400K 9°
NAUTICAL MILES
1 2 3 4 5
ROSARIO STRAIT


EQUILIBRIUM RUDDER BEFORE TURN
SPEED = 4
WIND = 270°/40°
CURRENTS = 020°/3.8
NORTH
80K -29°
120K -30°
165K -30°
280K (OFF COURSE)
400K -26°
80K -29°
120K -12°
165K -12°
280K -27°
400K -24°
NAUTICAL MILES
1 2 3 4 5
ROSARIO STRAIT

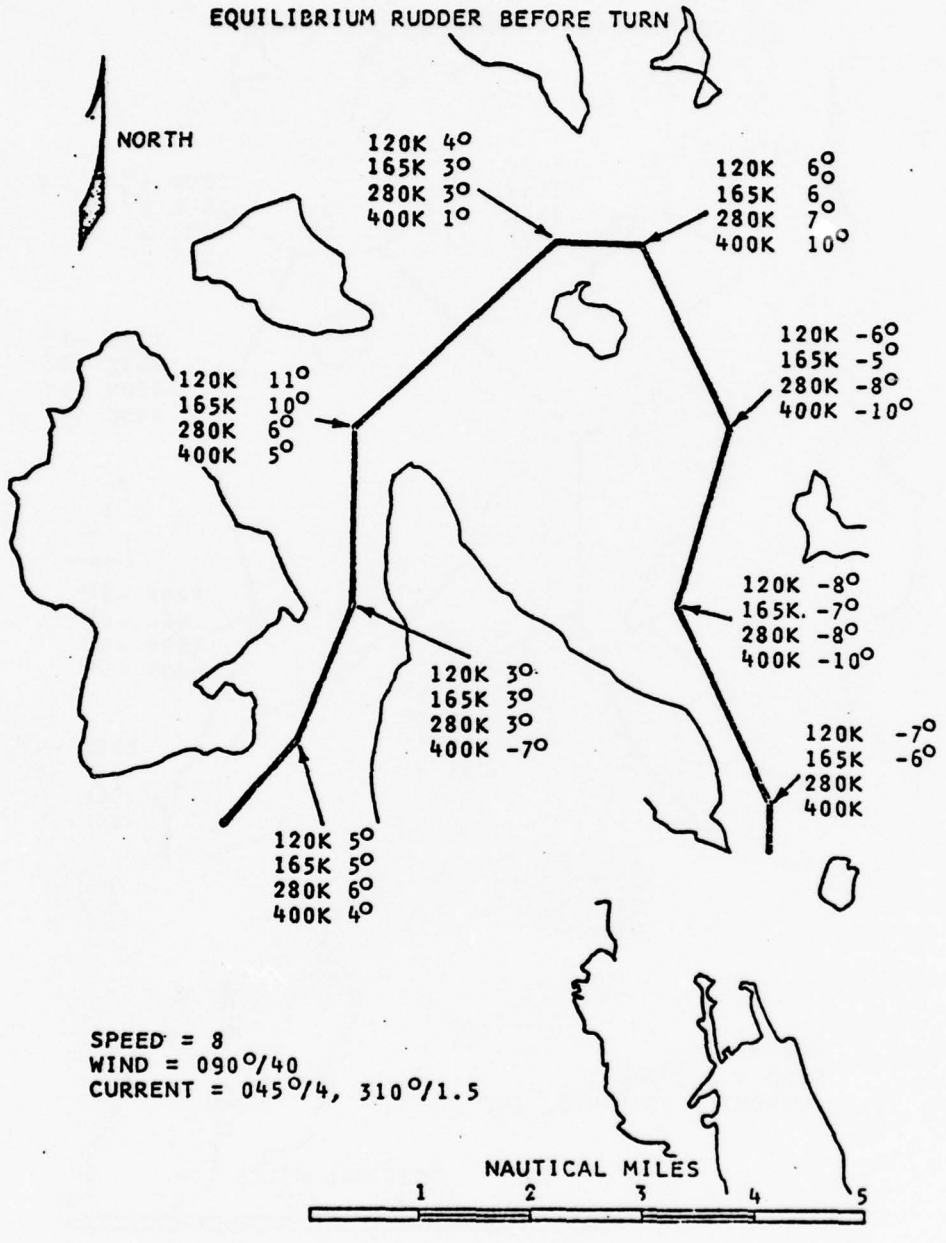

EQUILIBRIUM RUDDER BEFORE TURN
SPEED = 4
WIND = 090°/40
CURRENT = 020°/3.8
NORTH
80K 28° (OFF COURSE)
120K 12°
165K 14°
280K 35° (OFF COURSE)
400K 24° (OFF COURSE)
80K 27°
120K 35°
165K 34°
280K 25°
400K 18°
NAUTICAL MILES
1 2 3 4 5
ROSARIO STRAIT



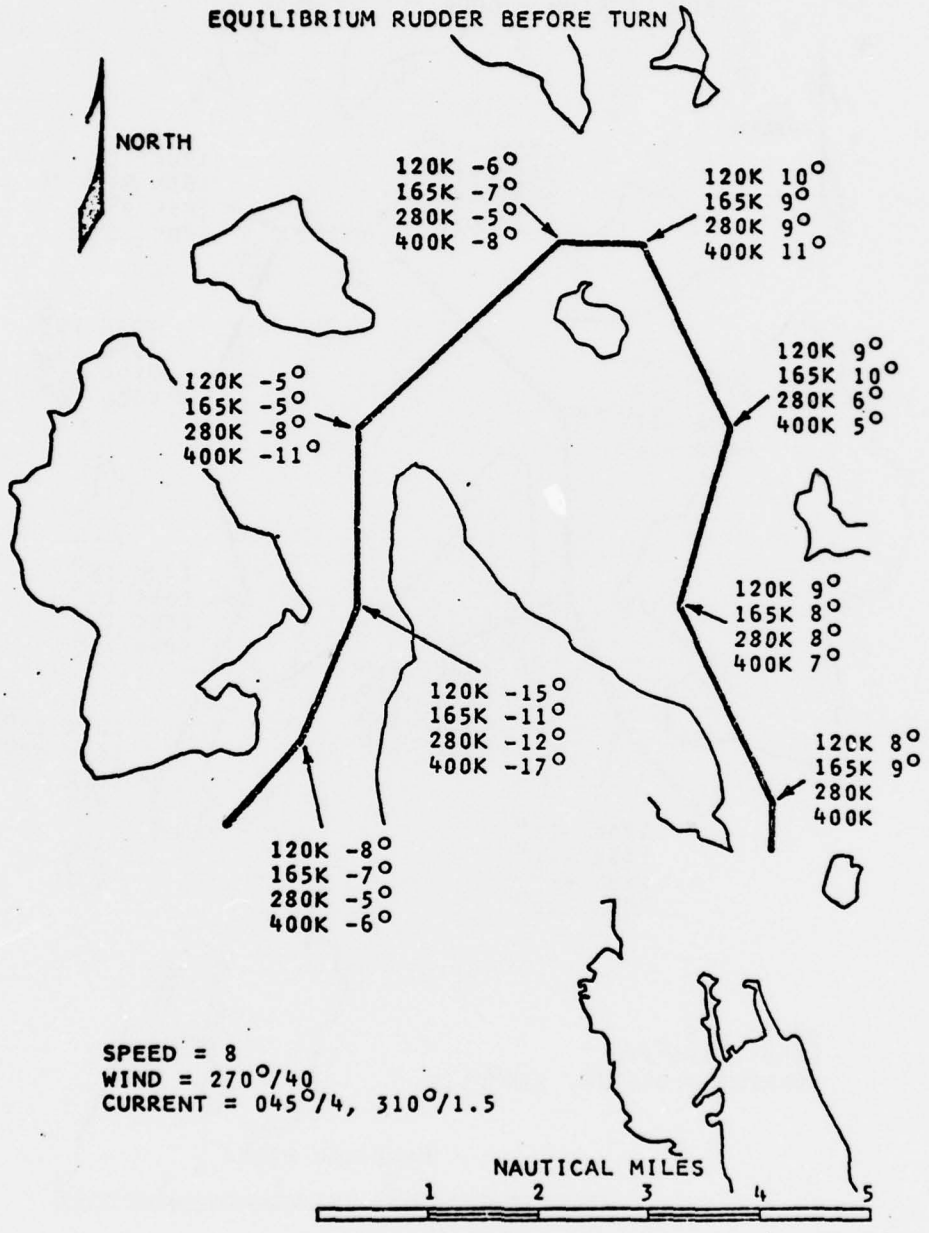
BELLINGHAM CHANNEL

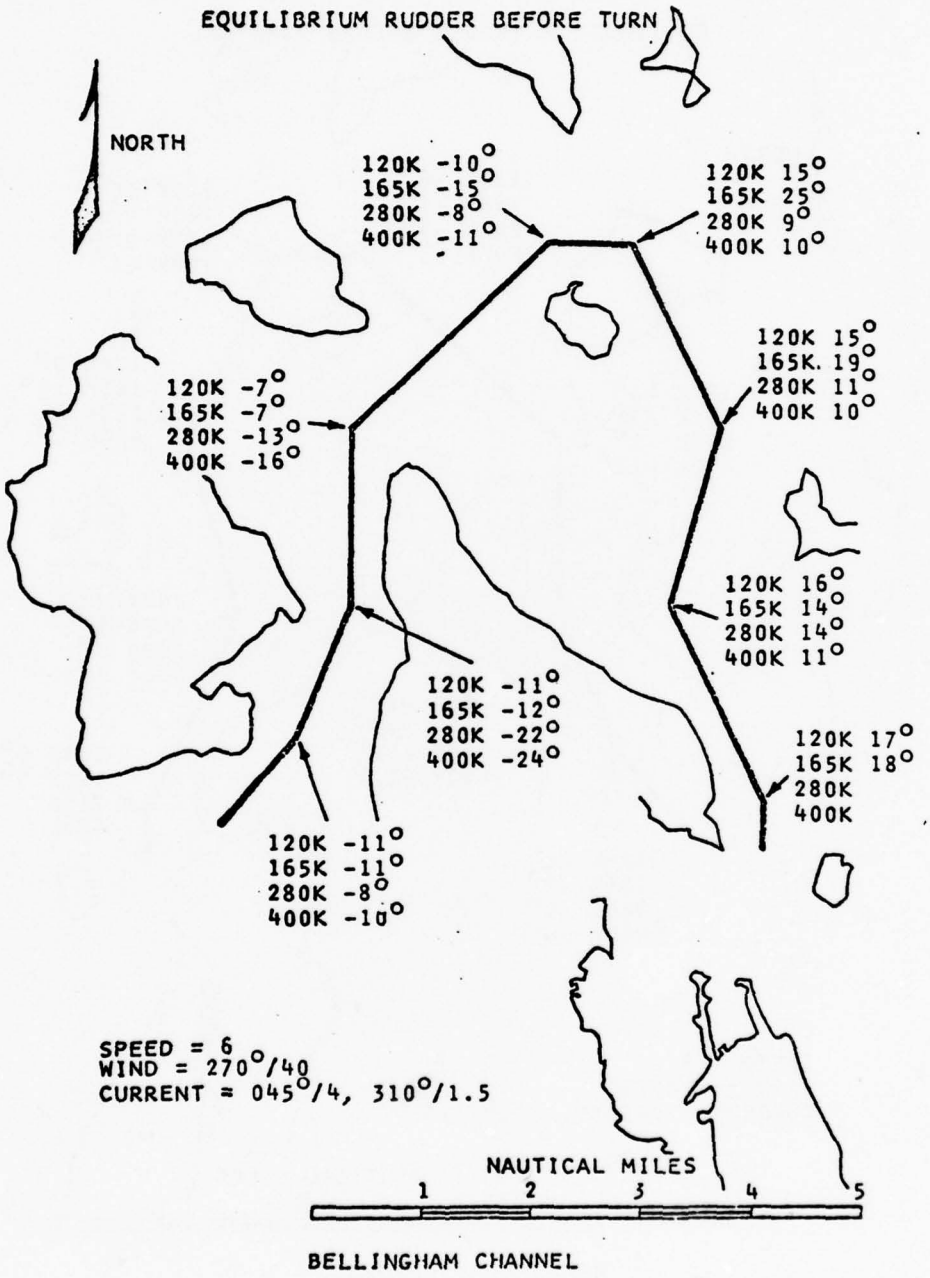


BELLINGHAM CHANNEL

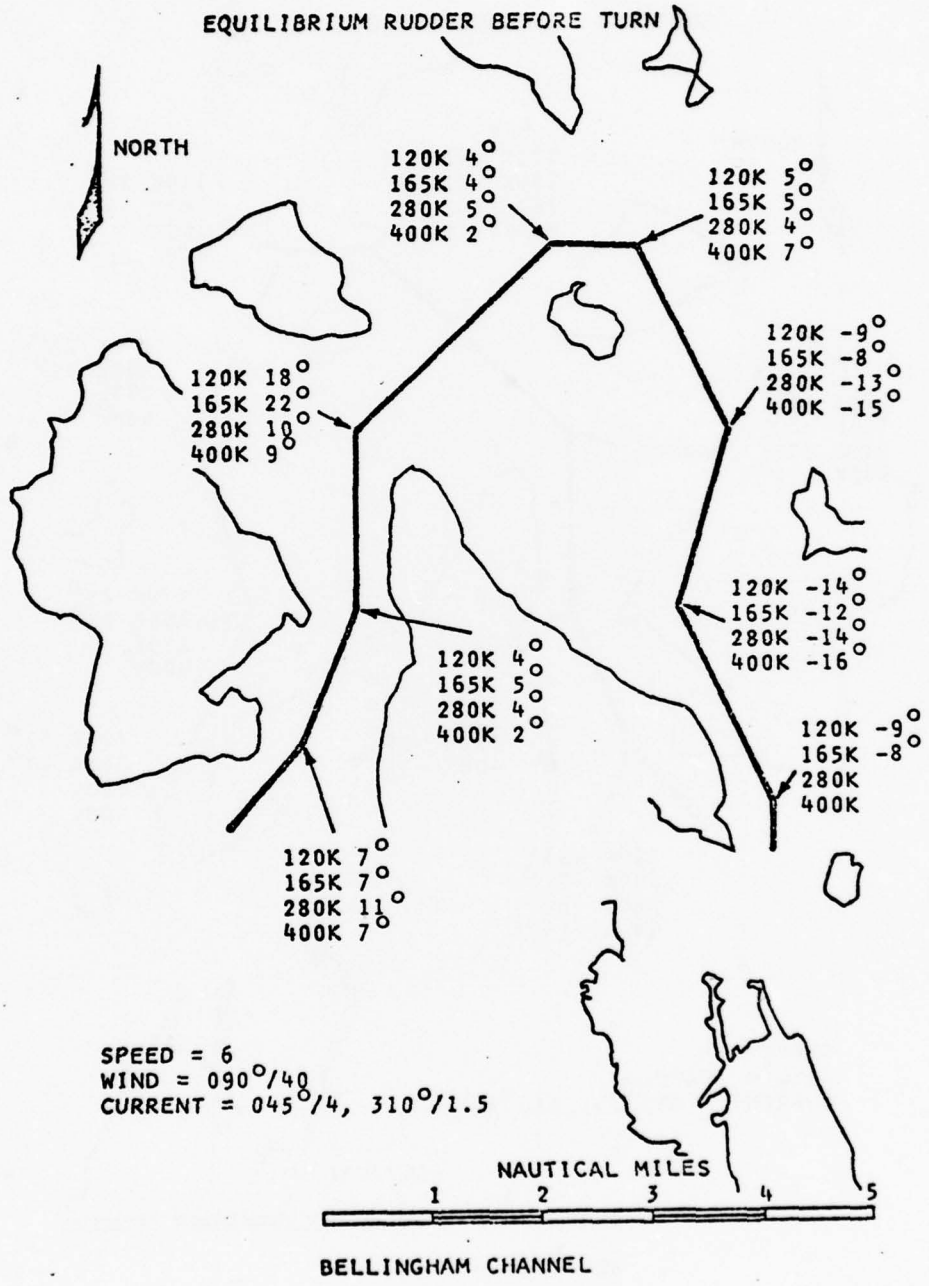


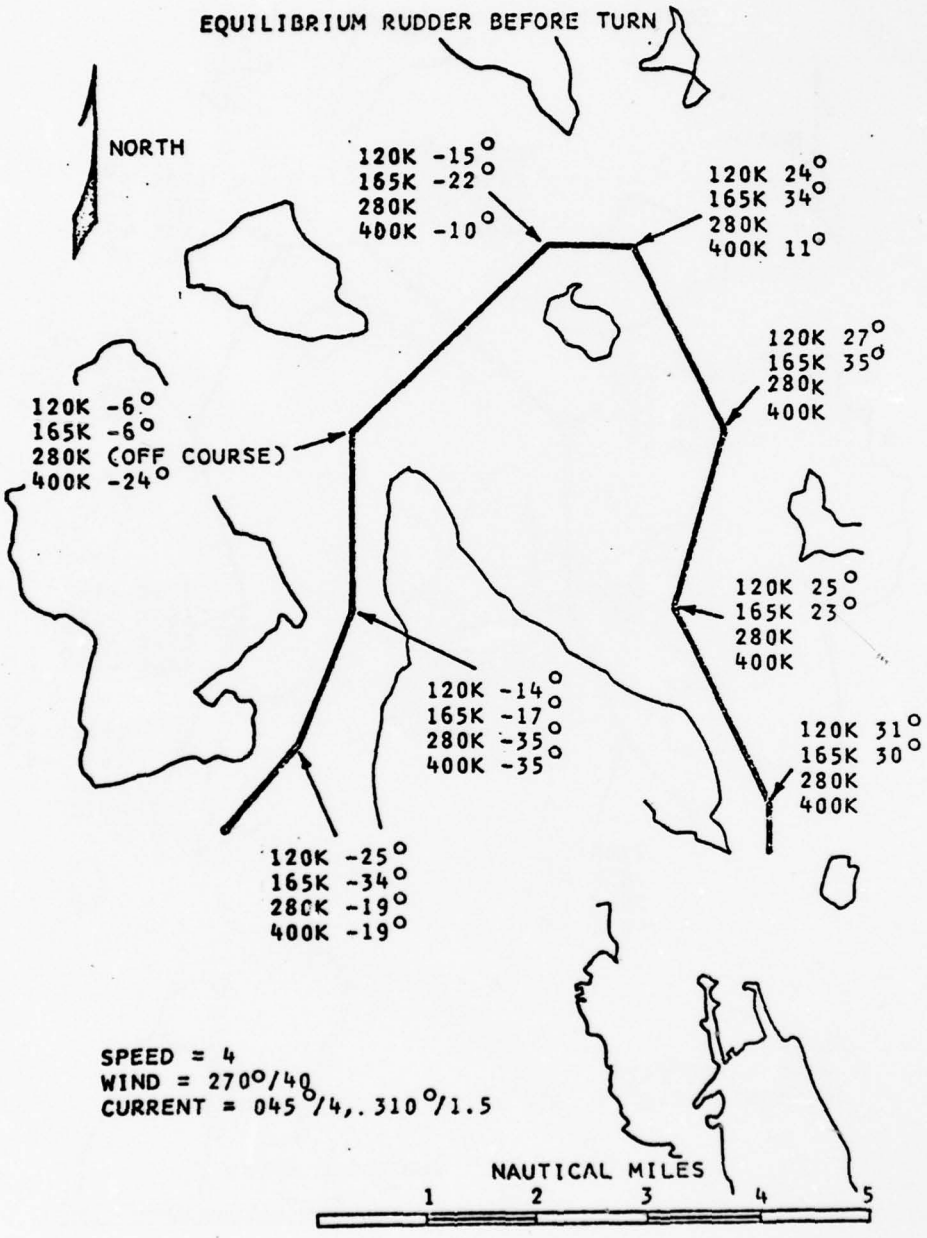
BELLINGHAM CHANNEL


EQUILIBRIUM RUDDER BEFORE TURN
NORTH
120K -6°
165K -7°
280K -5°
400K -8°
120K 10°
165K 9°
280K 9°
400K 11°
120K 9°
165K 10°
280K 6°
400K 5°
120K -5°
165K -5°
280K -8°
400K -11°
120K 9°
165K 8°
280K 8°
400K 7°
120K -15°
165K -11°
280K -12°
400K -17°
120K 8°
165K 9°
280K
400K
120K -8°
165K -7°
280K -5°
400K -6°
SPEED = 8
WIND = 270°/40
CURRENT = 045°/4, 310°/1.5
NAUTICAL MILES
1
2
3
4
5
BELLINGHAM CHANNEL

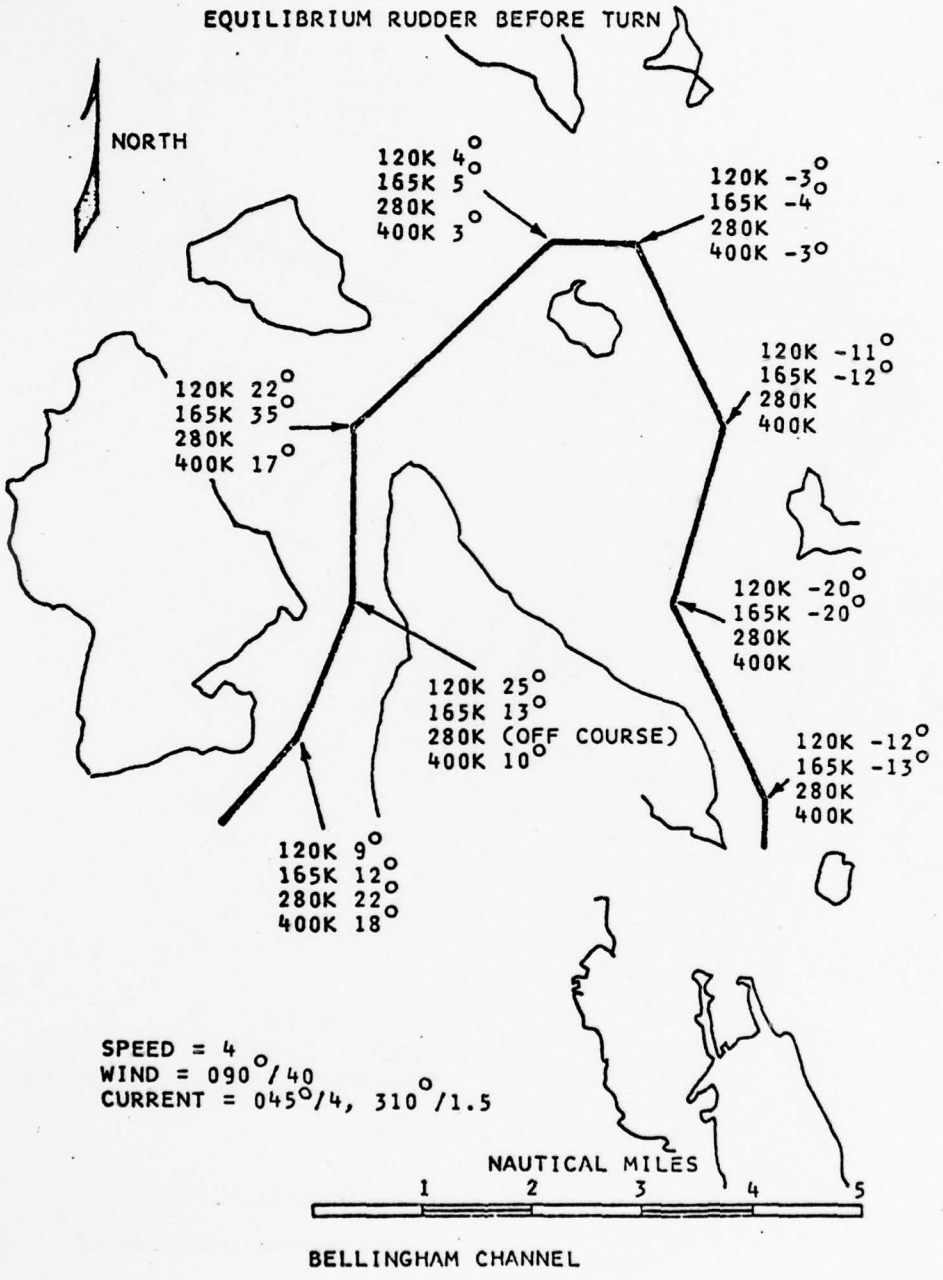


BELLINGHAM CHANNEL

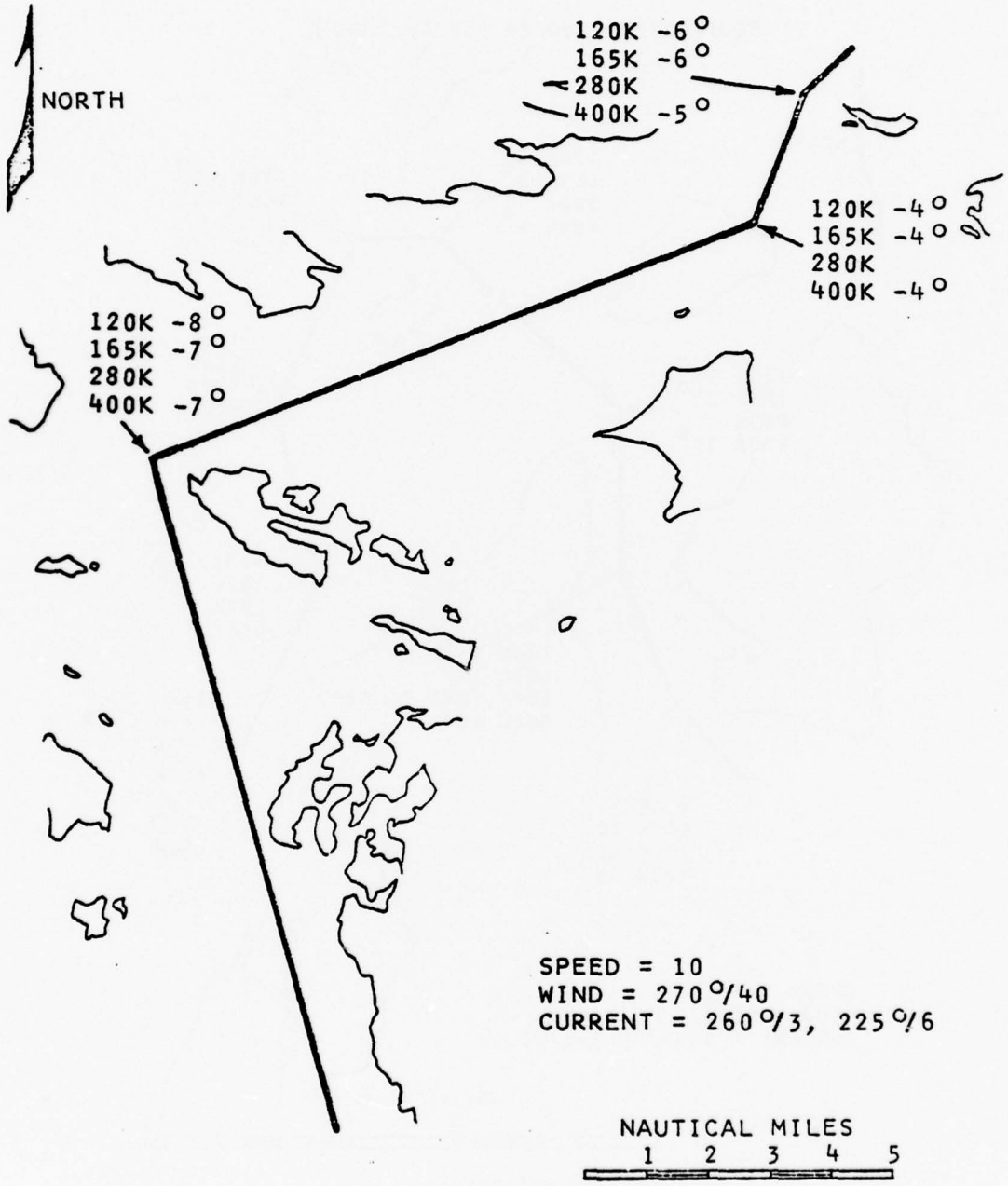

EQUILIBRIUM RUDDER BEFORE TURN
NORTH
120K 4°
165K 4°
280K 5°
400K 2°
120K 5°
165K 5°
280K 4°
400K 7°
120K -9°
165K -8°
280K -13°
400K -15°
120K 18°
165K 22°
280K 10°
400K 9°
120K -14°
165K -12°
280K -14°
400K -16°
120K 4°
165K 5°
280K 4°
400K 2°
120K -9°
165K -8°
280K
400K
120K 7°
165K 7°
280K 11°
400K 7°
SPEED = 6
WIND = 090°/40
CURRENT = 045°/4, 310°/1.5
NAUTICAL MILES
1
2
3
4
5
BELLINGHAM CHANNEL



BELLINGHAM CHANNEL

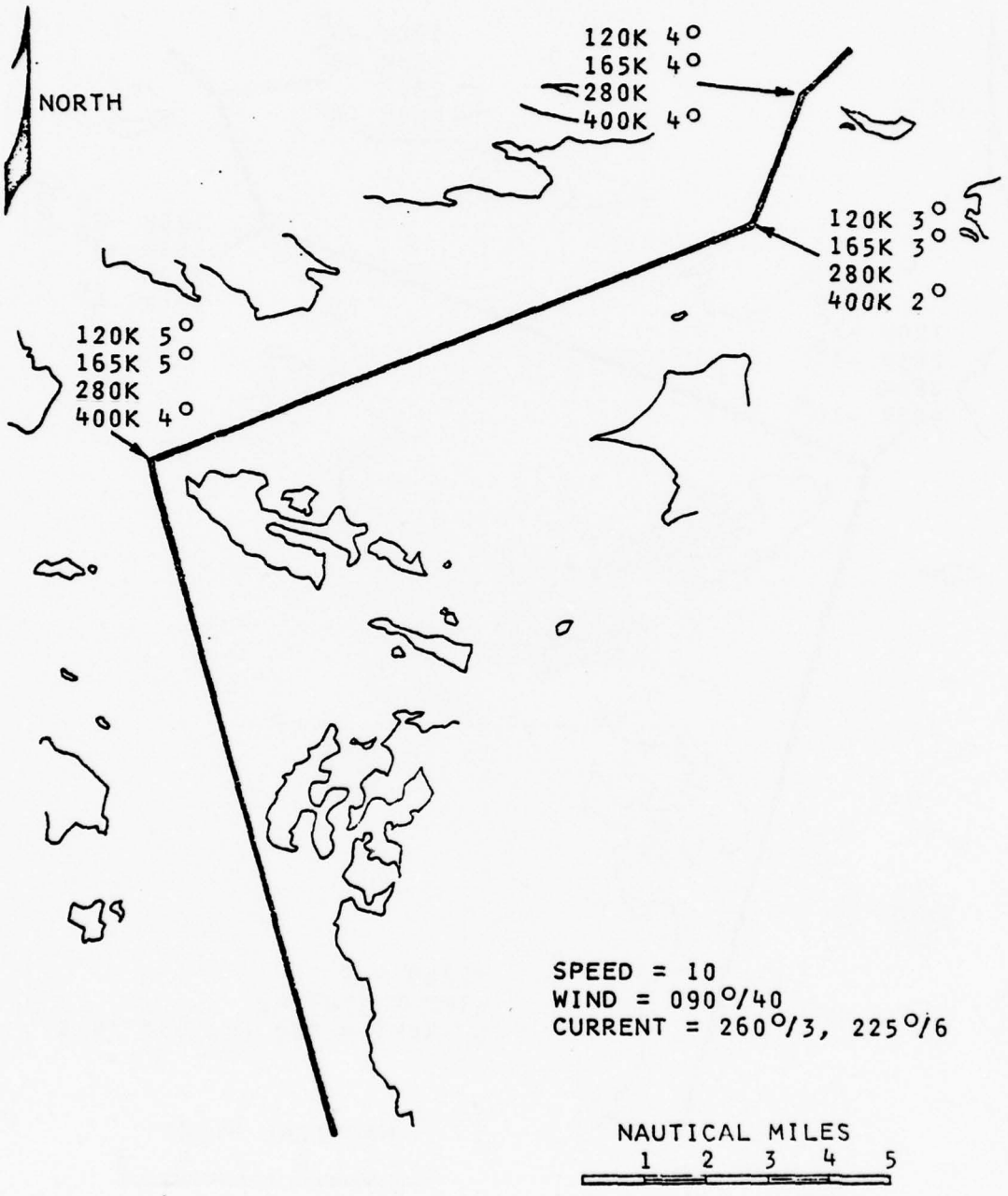

EQUILIBRIUM RUDDER BEFORE TURN
NORTH
120K 4°
165K 5°
280K
400K 3°
120K -3°
165K -4°
280K
400K -3°
120K -11°
165K -12°
280K
400K
120K 22°
165K 35°
280K
400K 17°
120K -20°
165K -20°
280K
400K
120K 25°
165K 13°
280K (OFF COURSE)
400K 10°
120K -12°
165K -13°
280K
400K
120K 9°
165K 12°
280K 22°
400K 18°
SPEED = 4
WIND = 090°/40
CURRENT = 045°/4, 310°/1.5
NAUTICAL MILES
1
2
3
4
5
BELLINGHAM CHANNEL

EQUILIBRIUM RUDDER BEFORE TURN



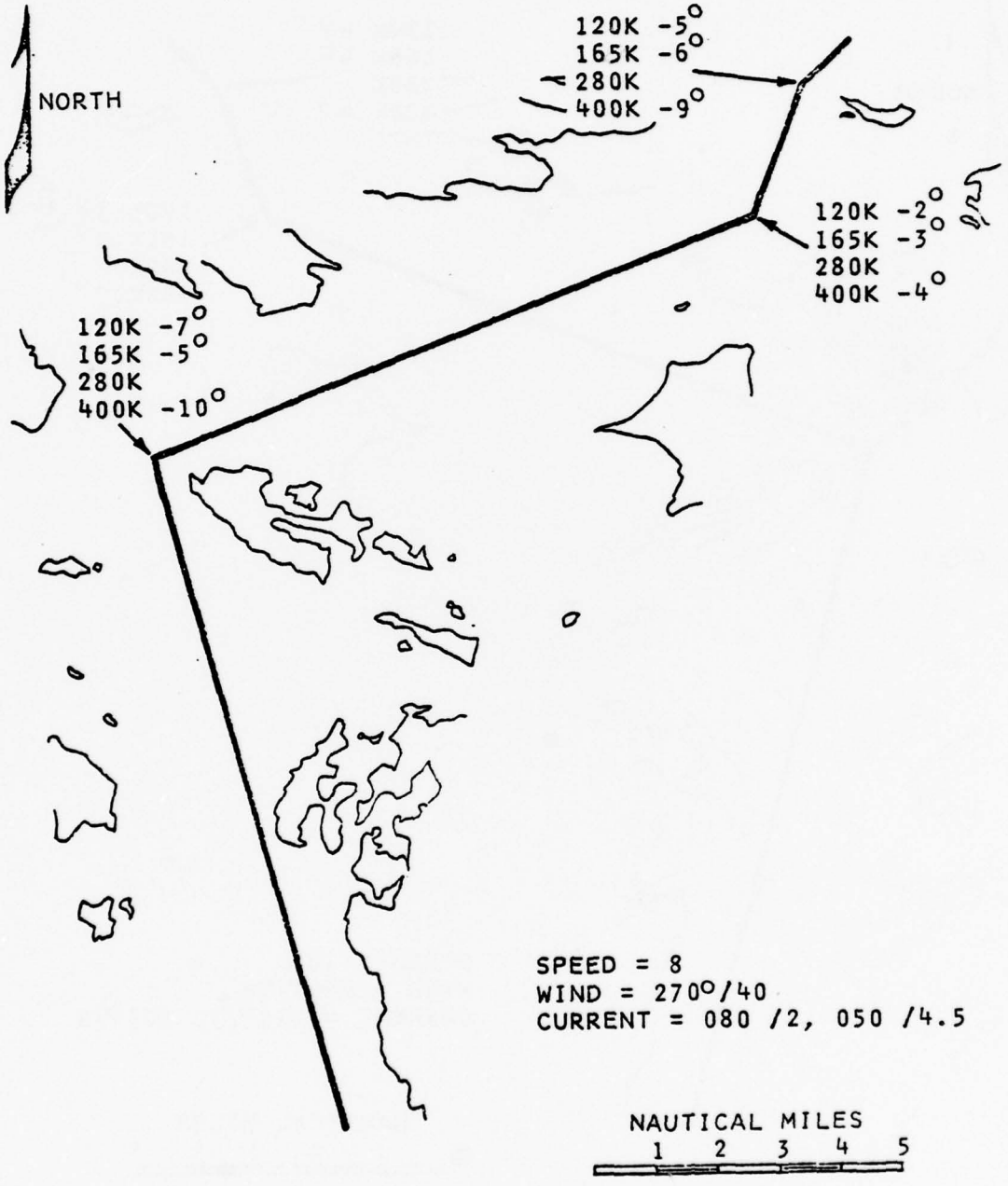
HARO STRAIT

EQUILIBRIUM RUDDER BEFORE TURN



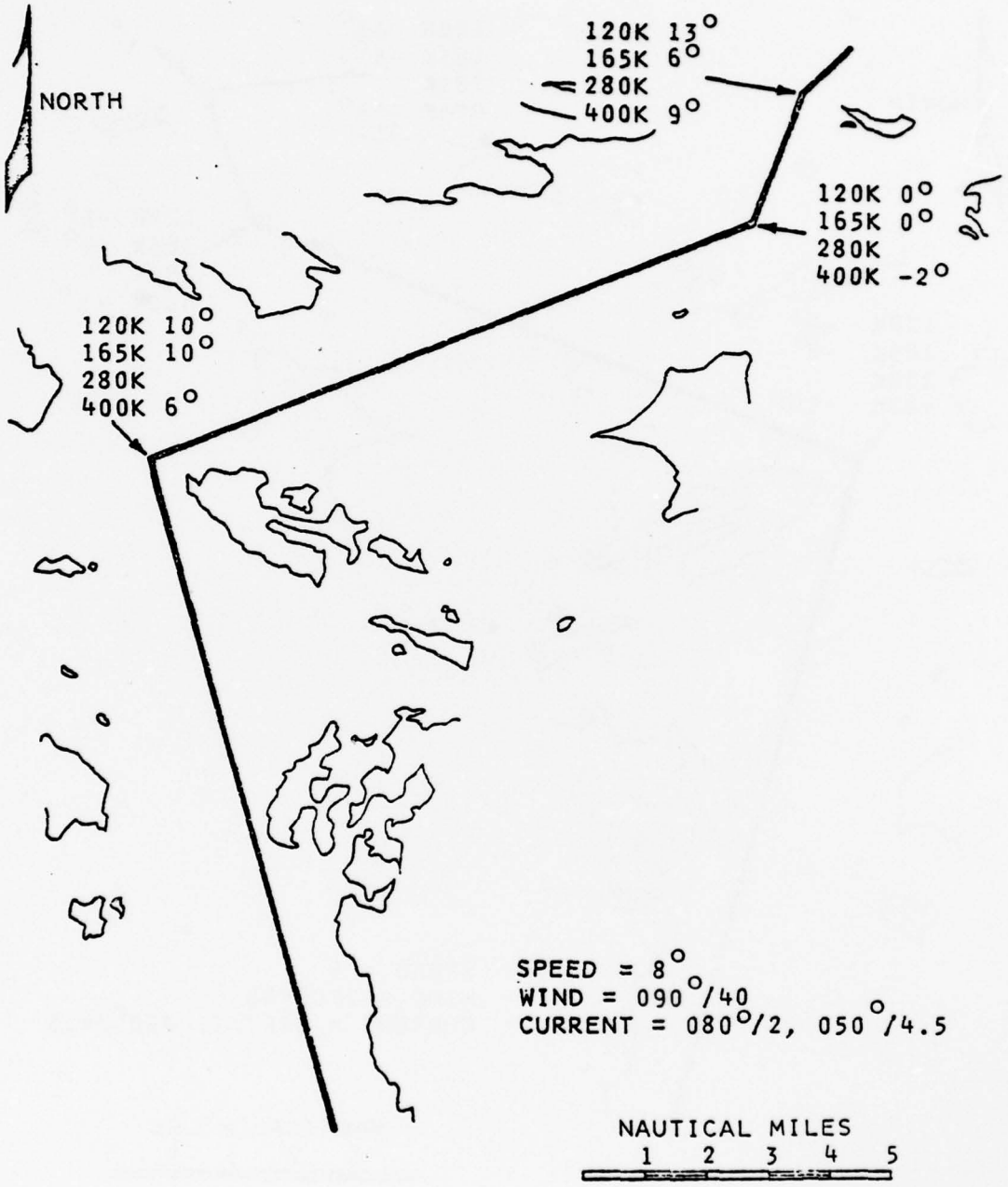
HARO STRAIT

EQUILIBRIUM RUDDER BEFORE TURN



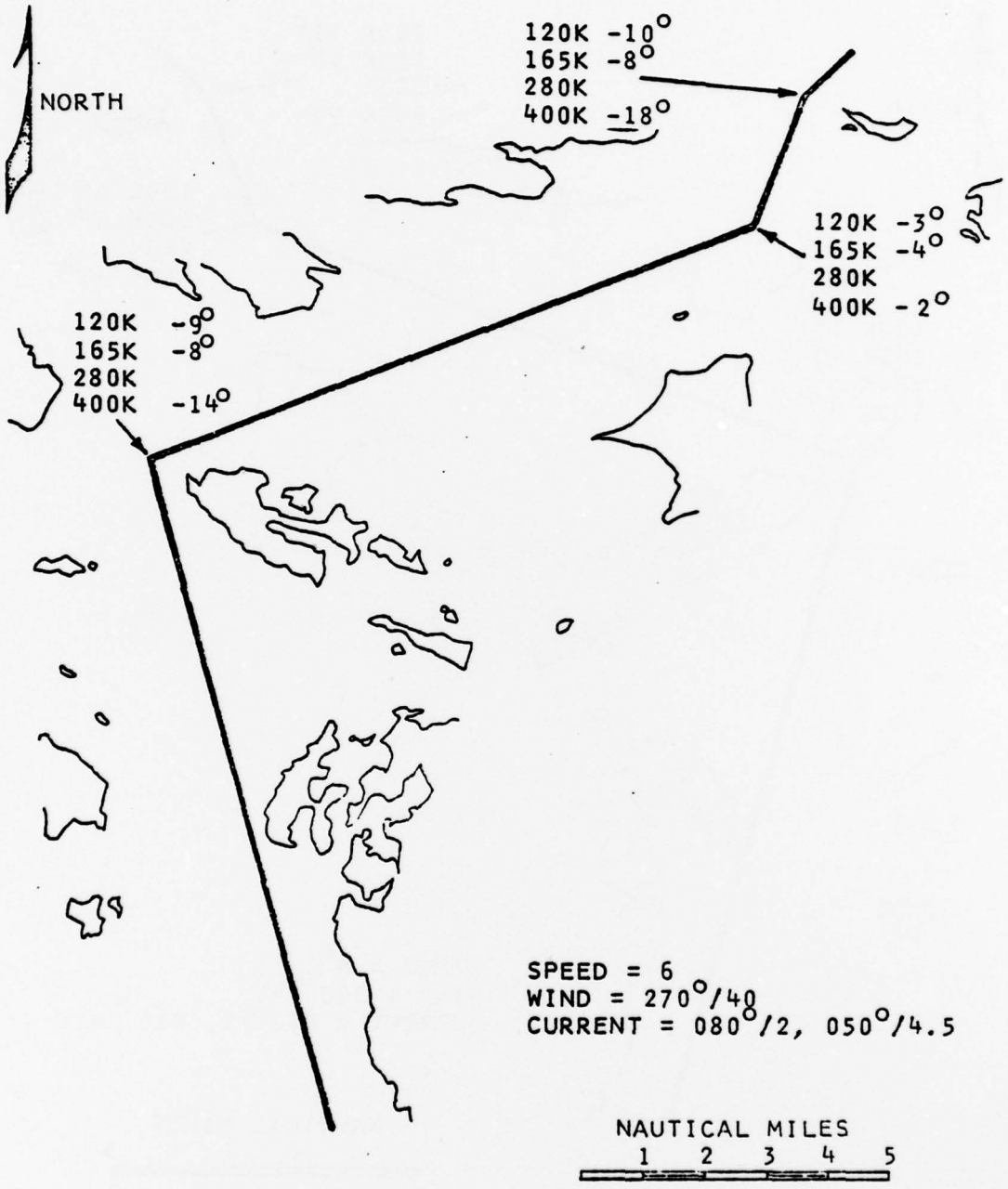
HARO STRAIT

EQUILIBRIUM RUDDER BEFORE TURN



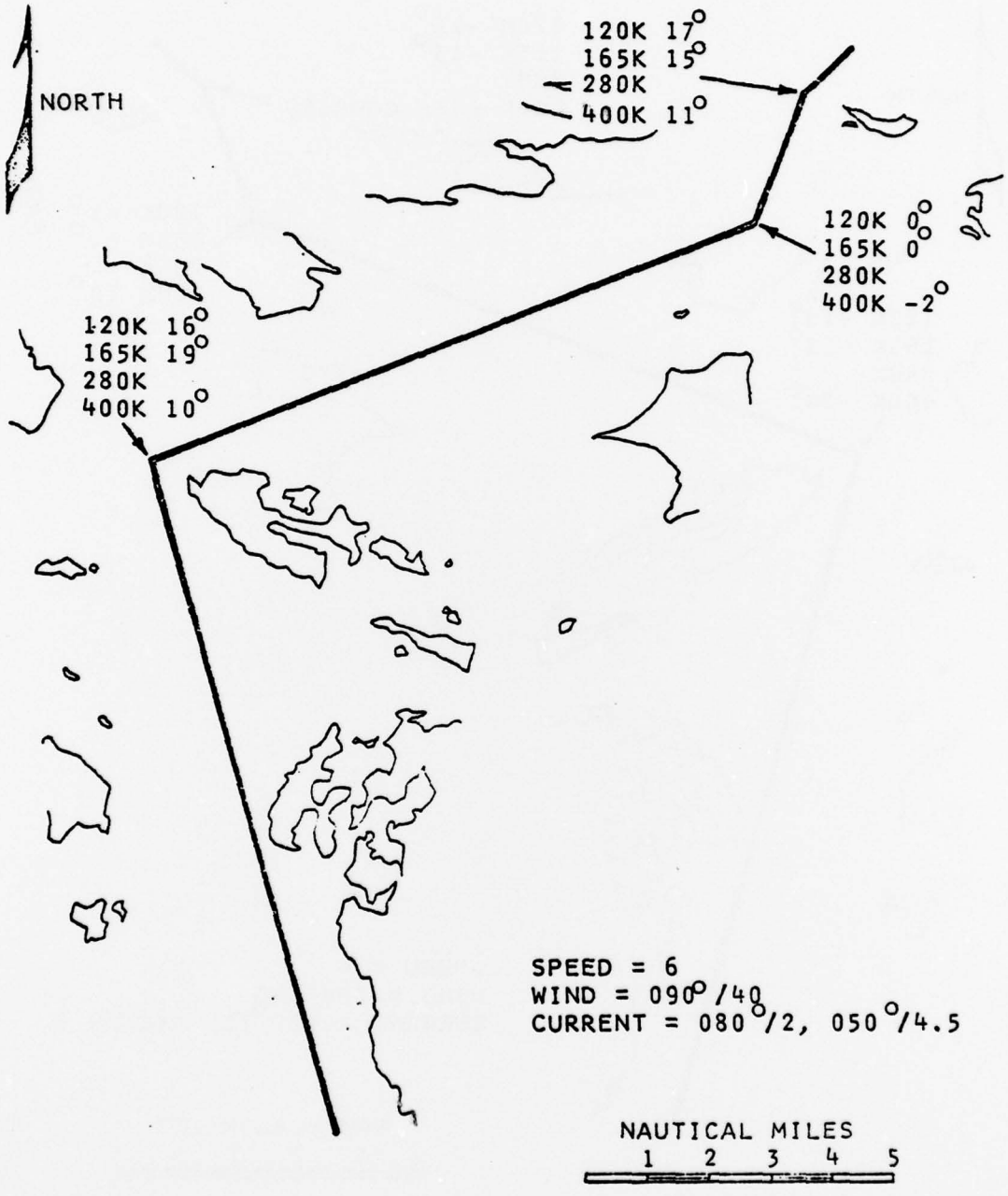
HARO STRAIT

EQUILIBRIUM RUDDER BEFORE TURN



HARO STRAIT

EQUILIBRIUM RUDDER BEFORE TURN



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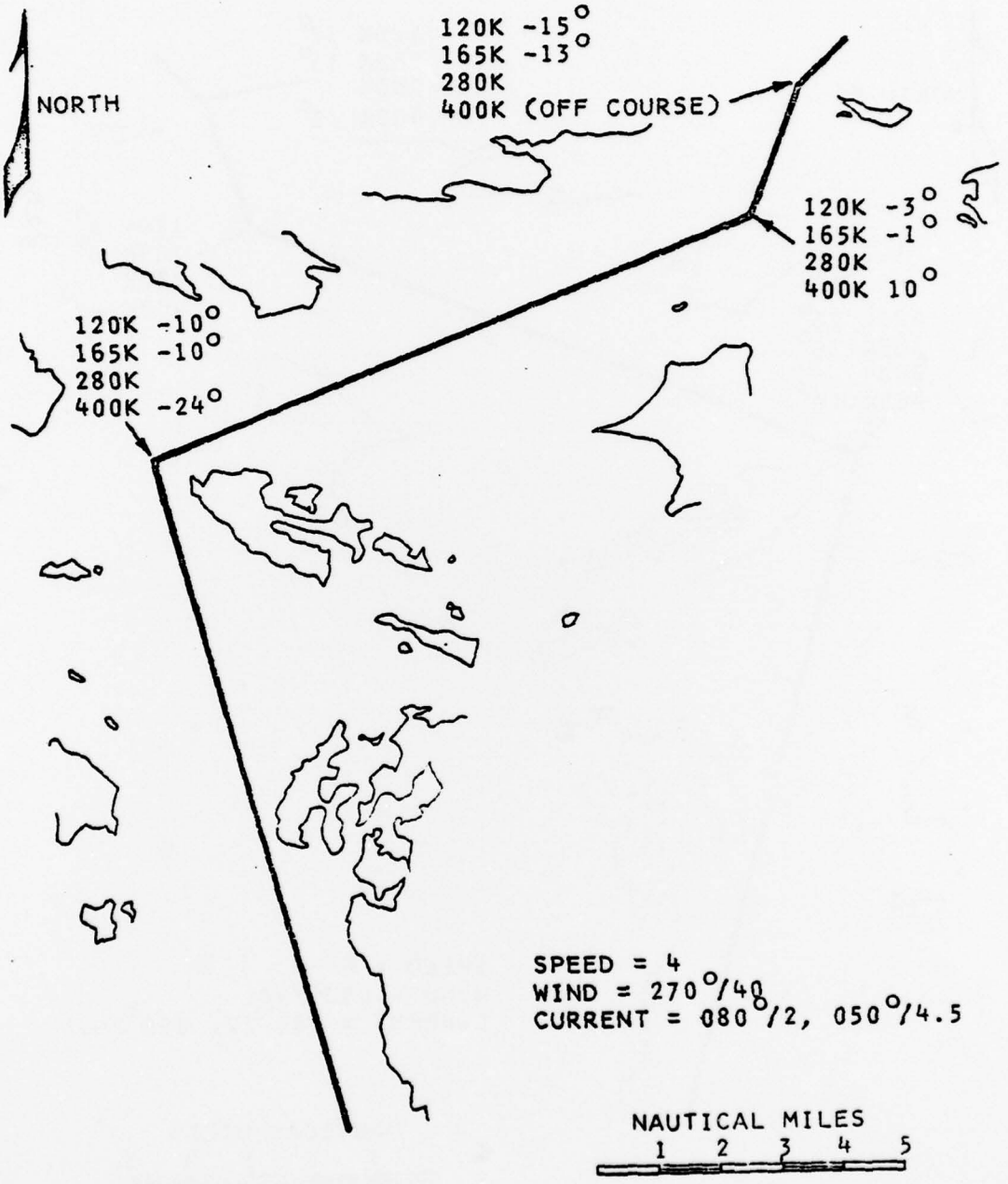

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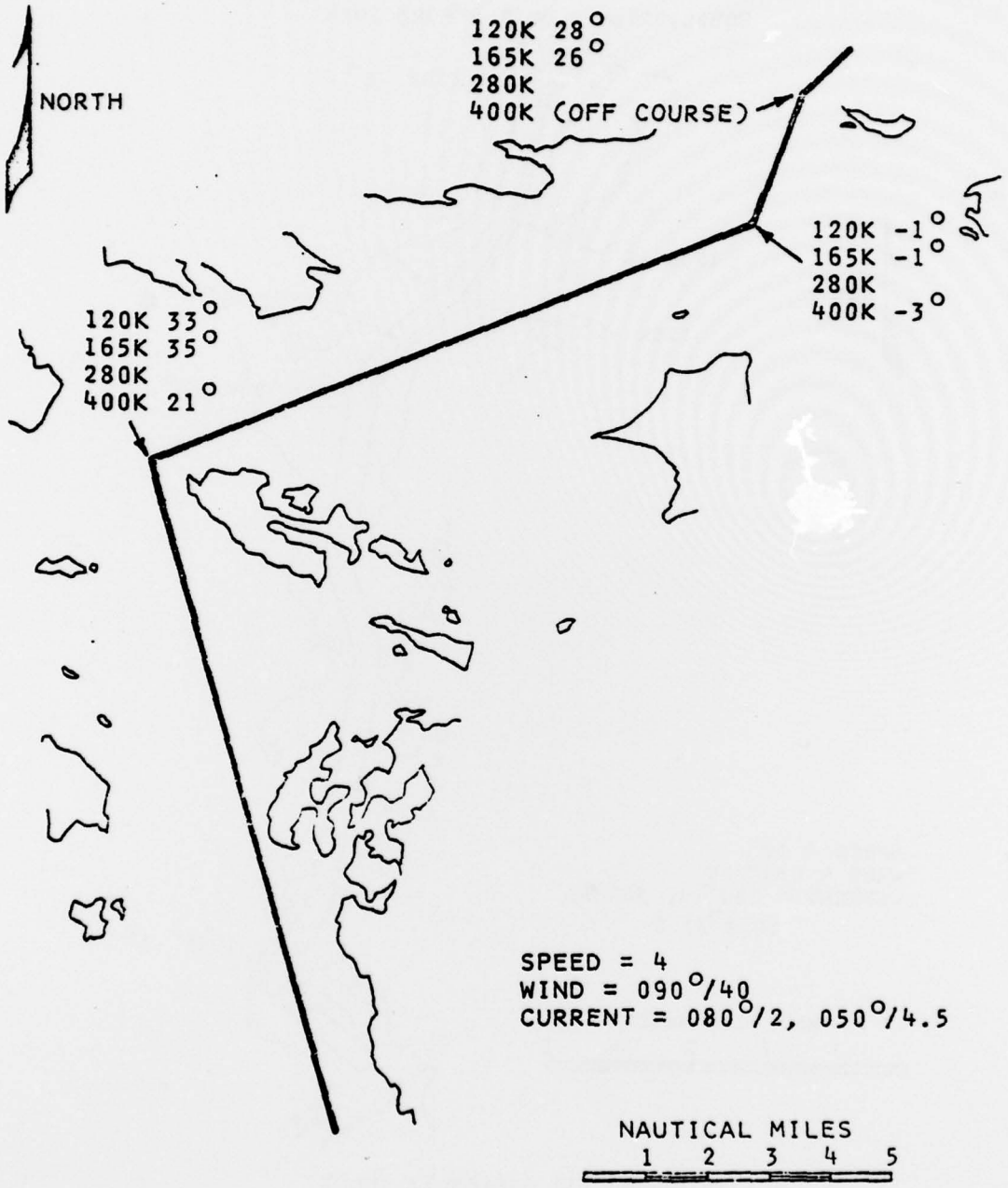
EQUILIBRIUM RUDDER BEFORE TURN



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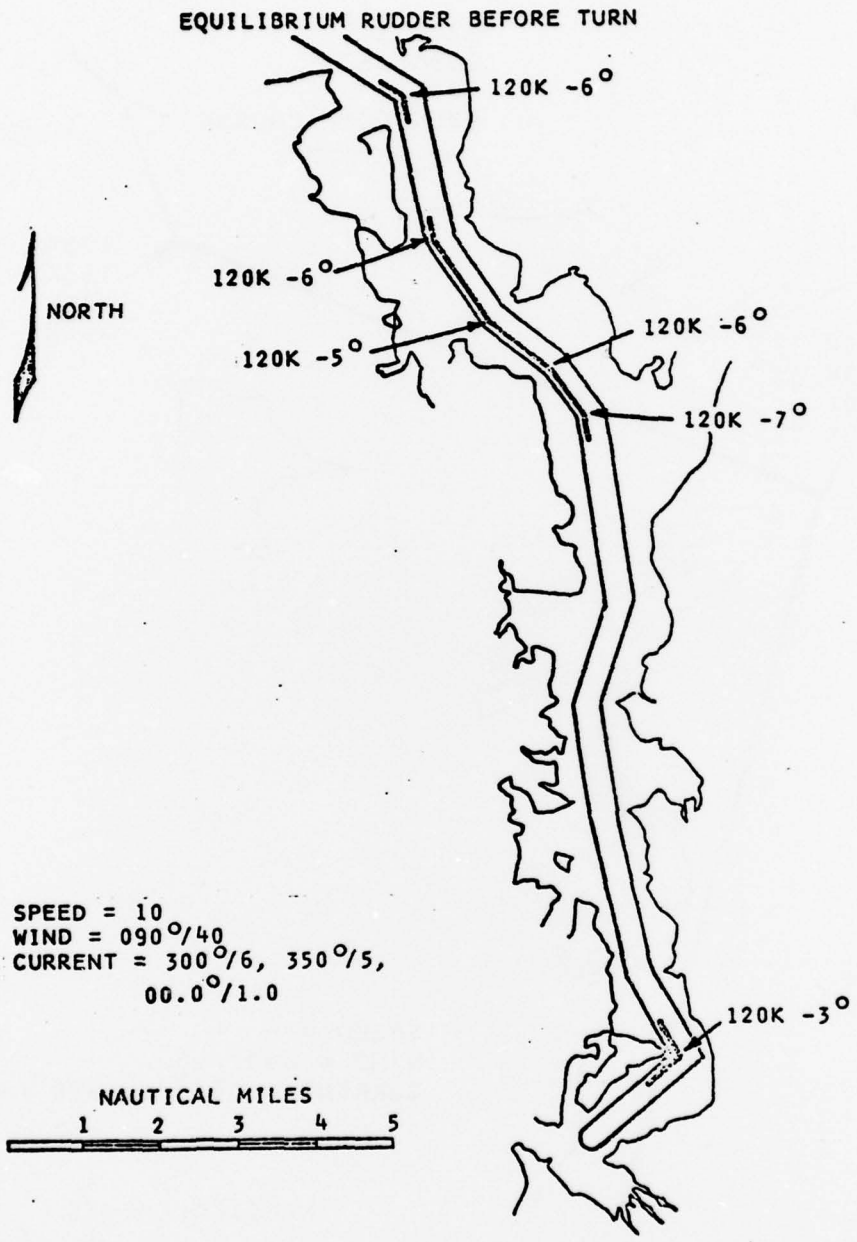
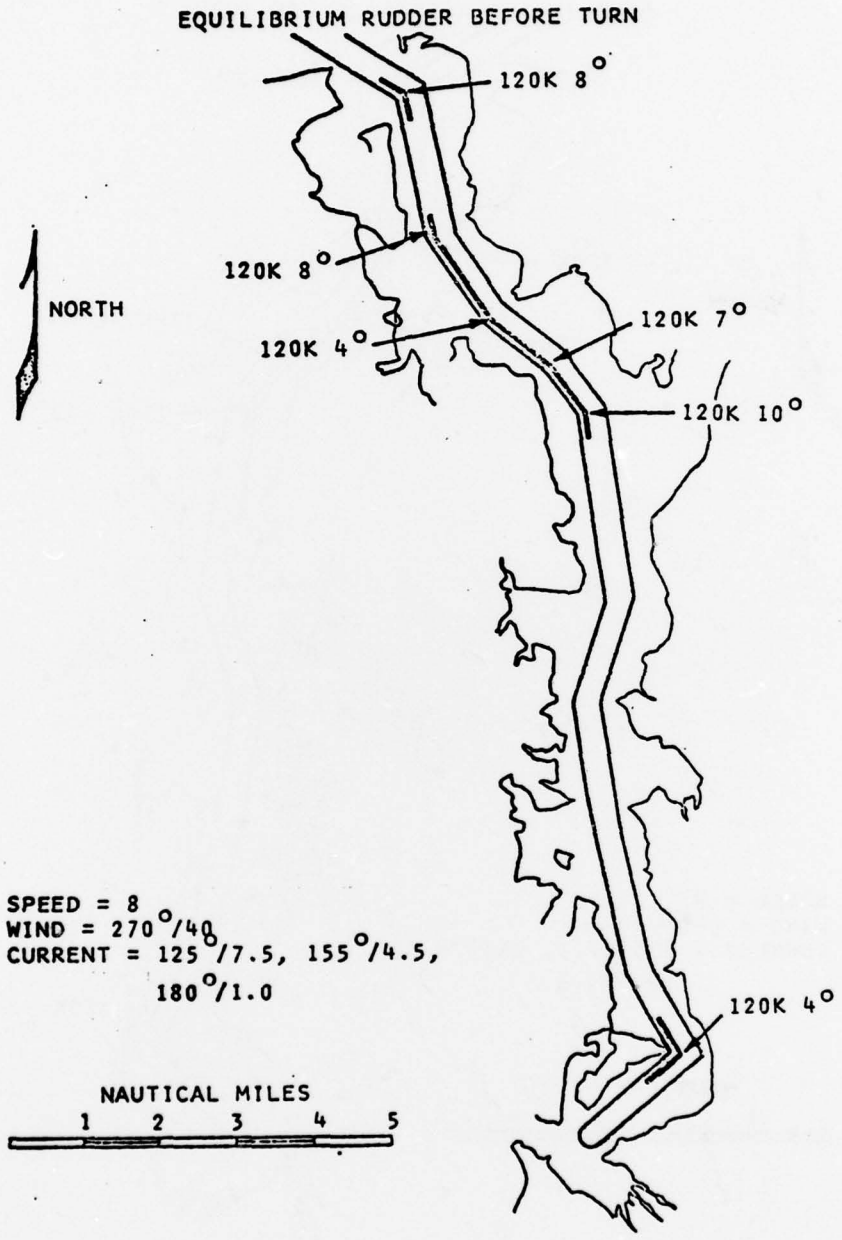


TACOMA VIA ADMIRALTY INLET



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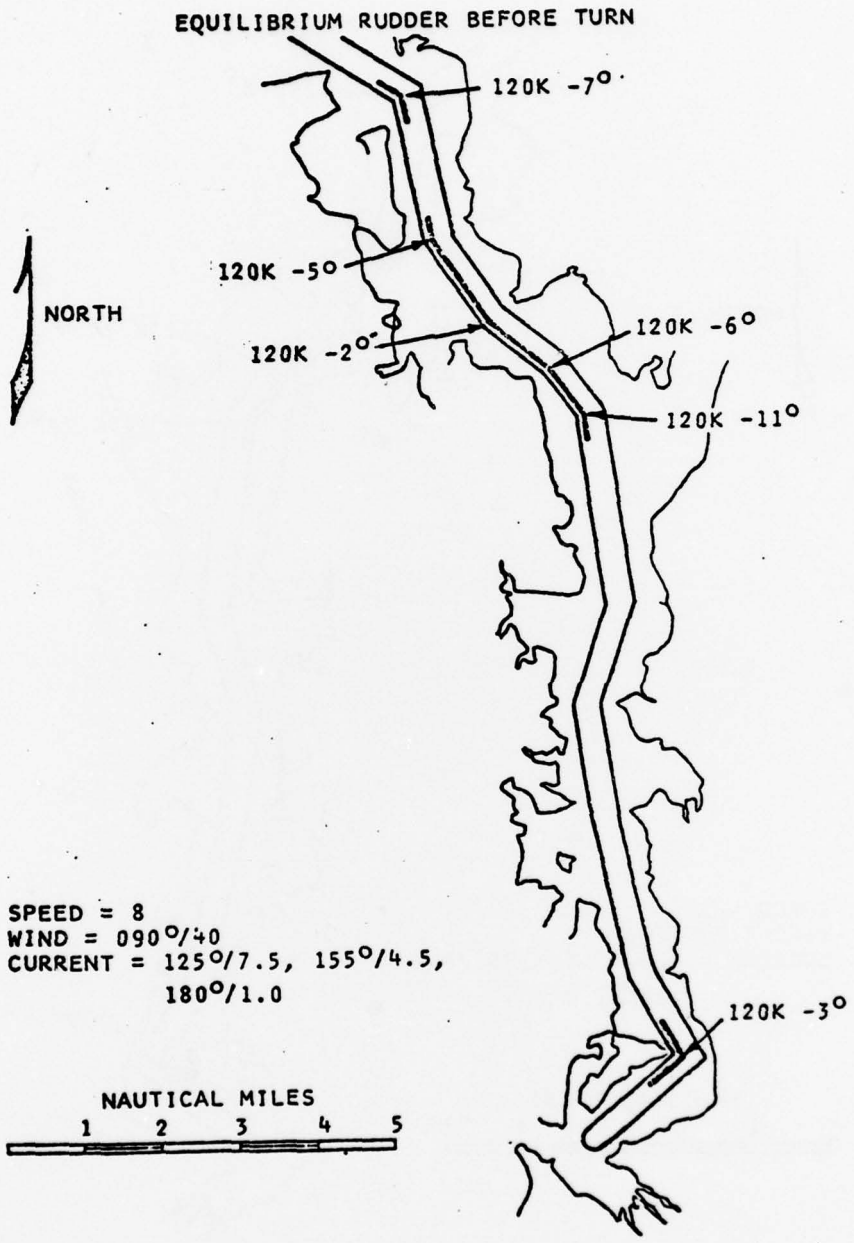

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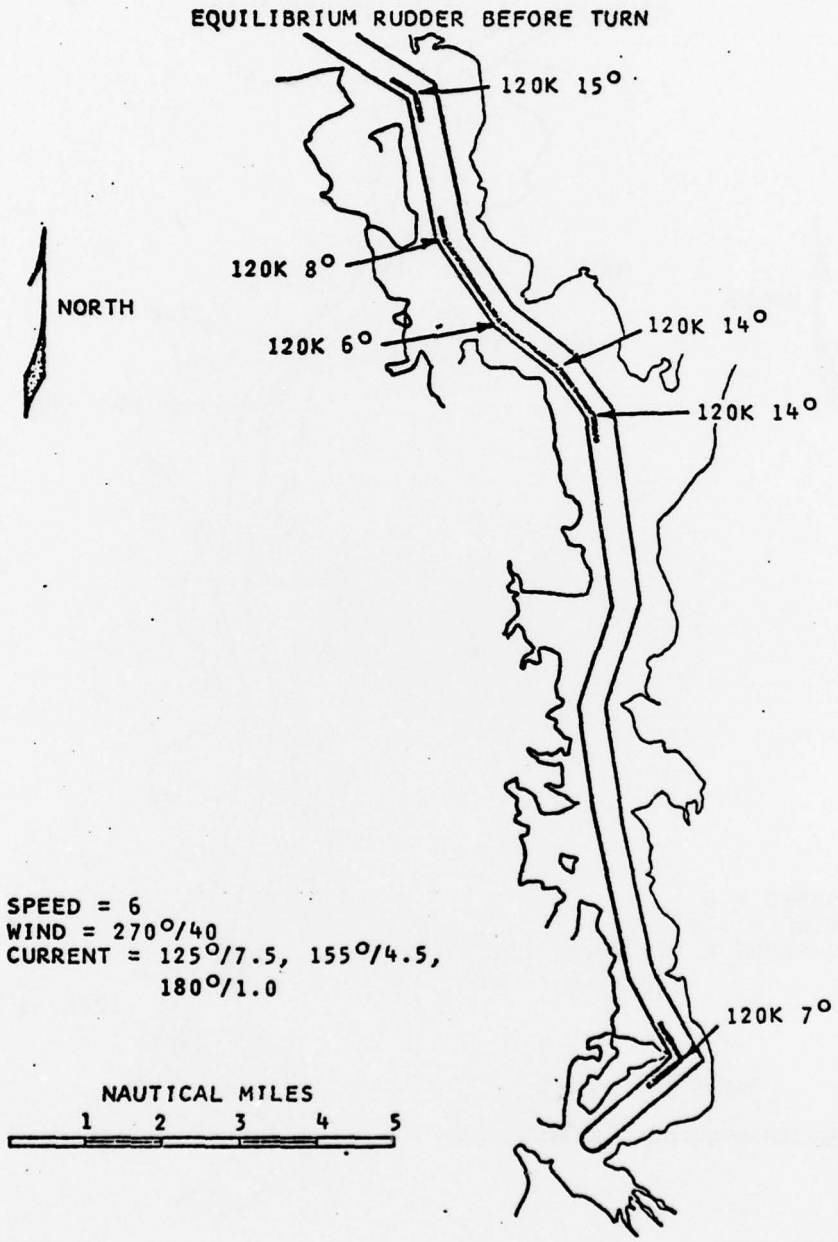

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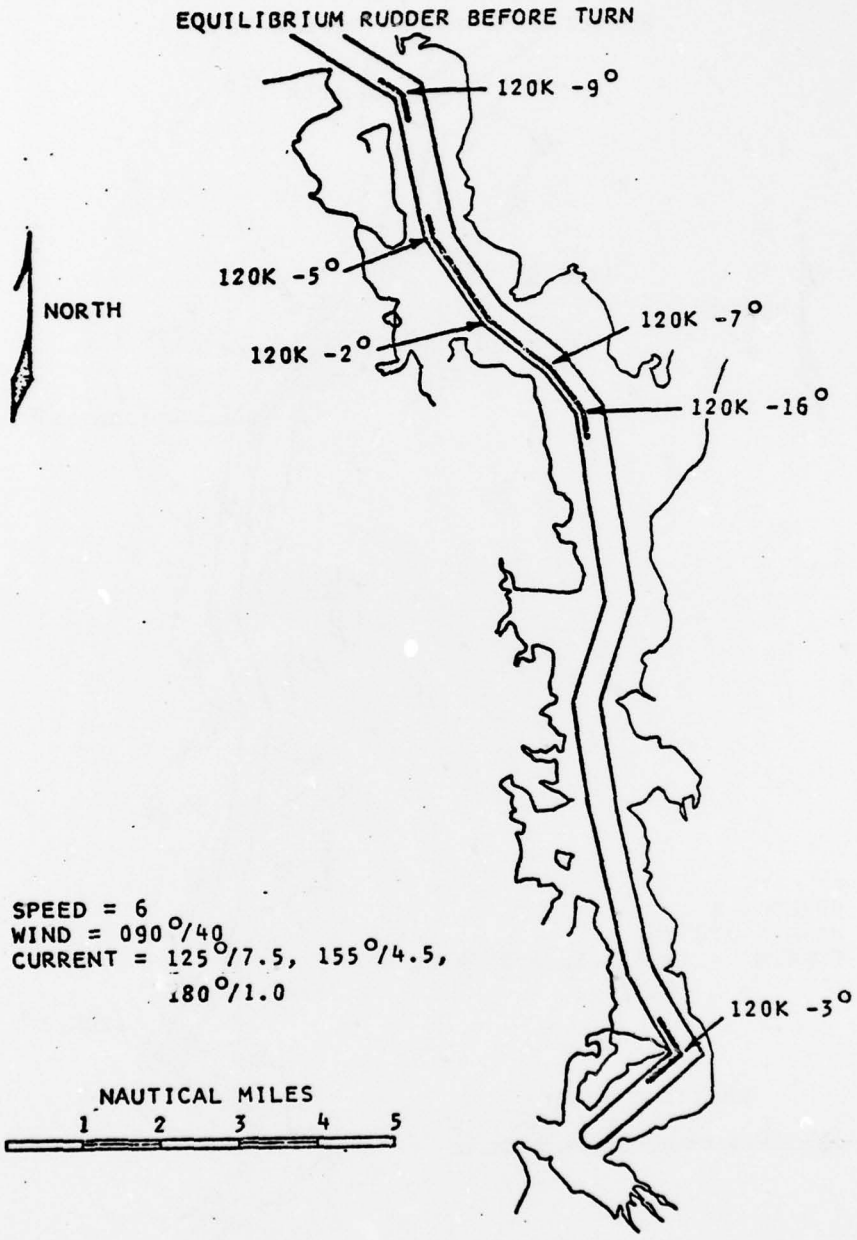

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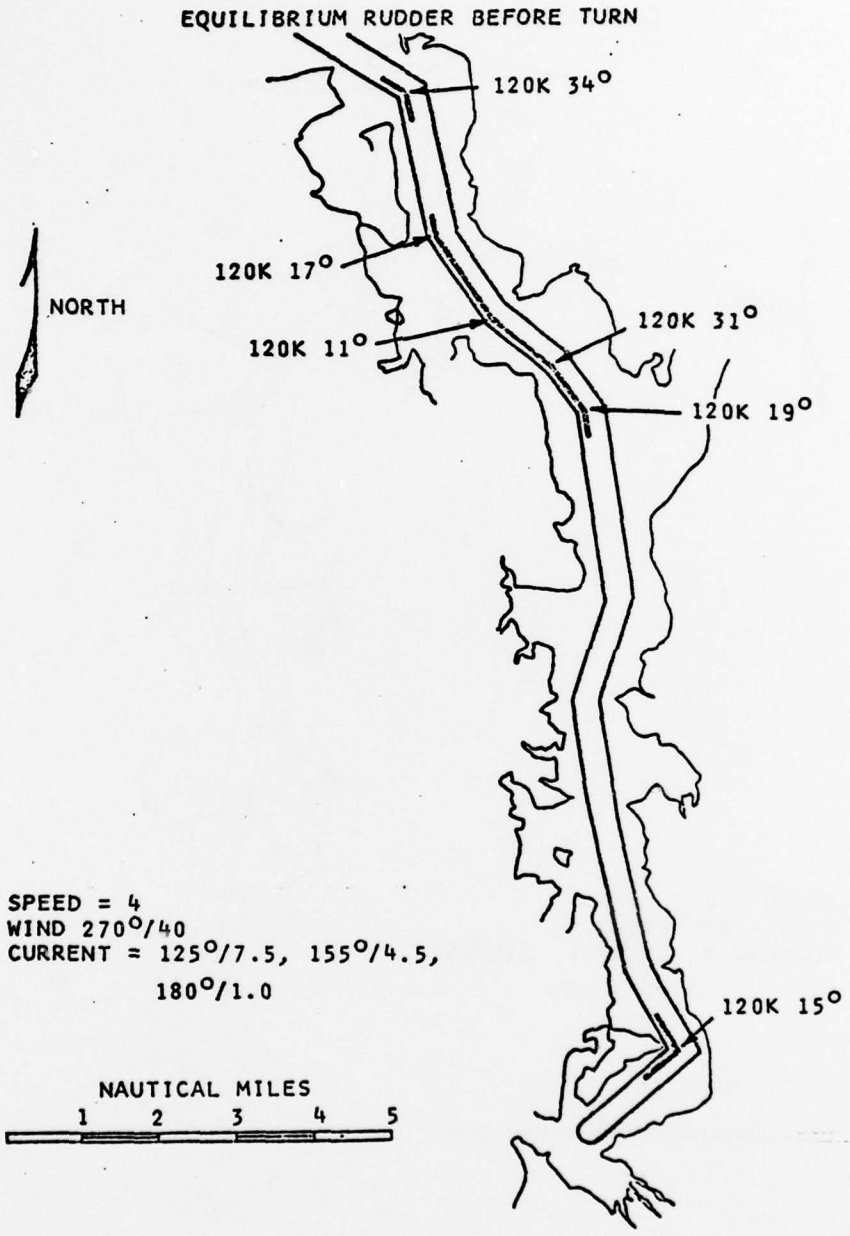

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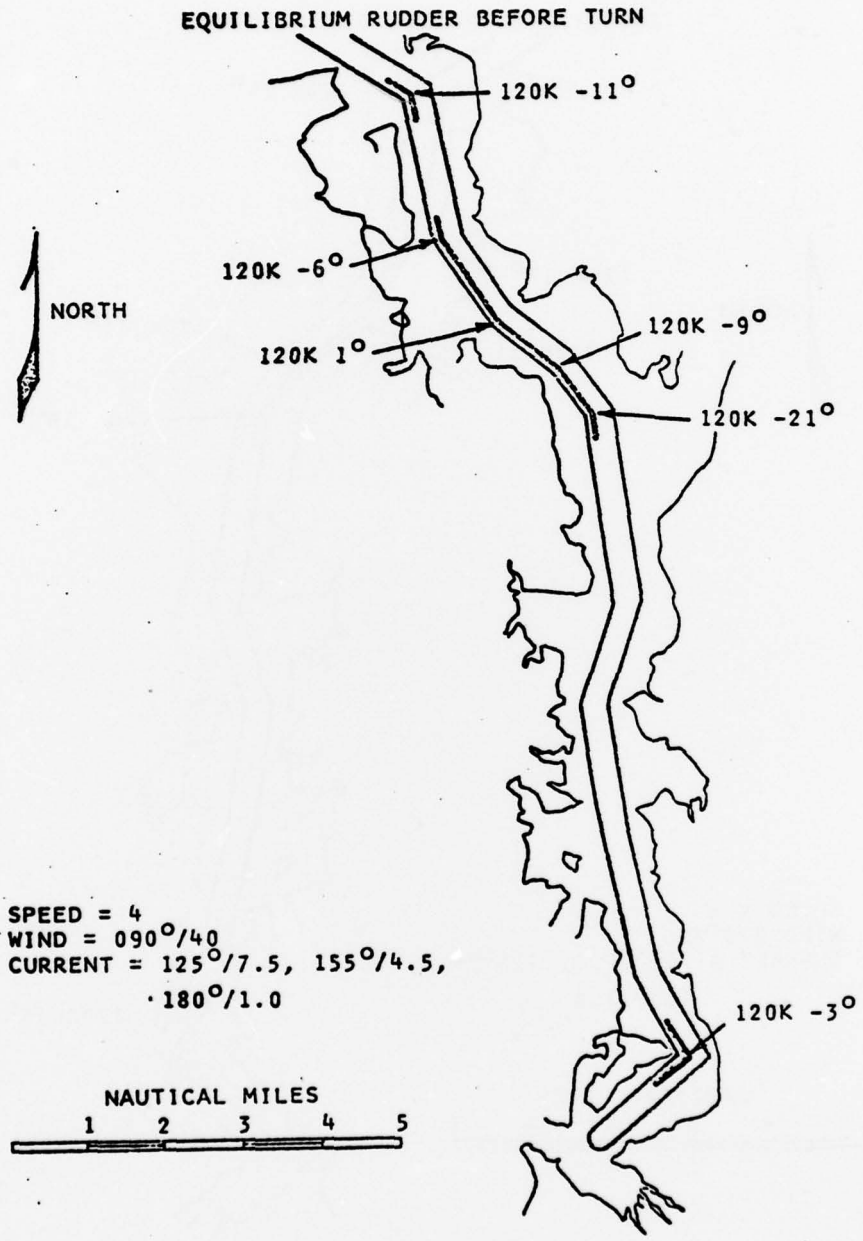

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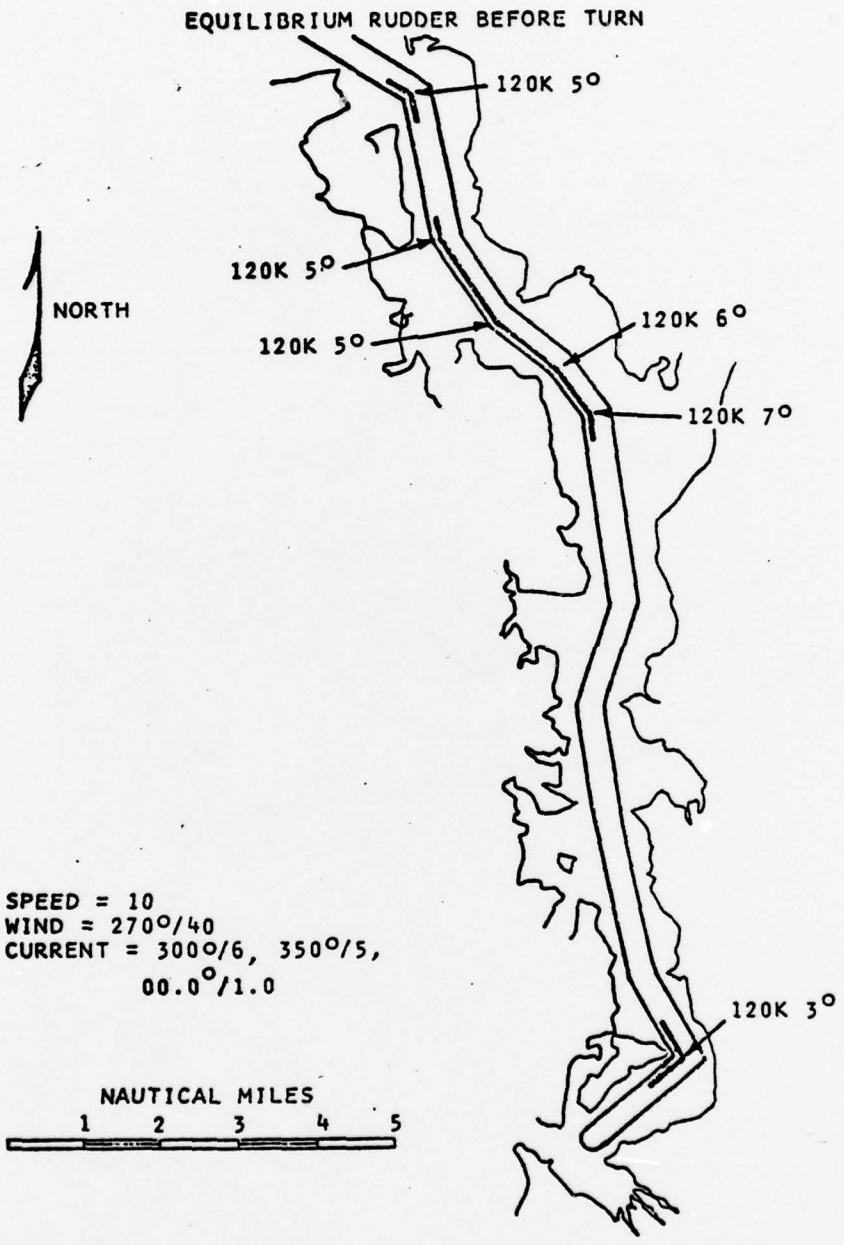

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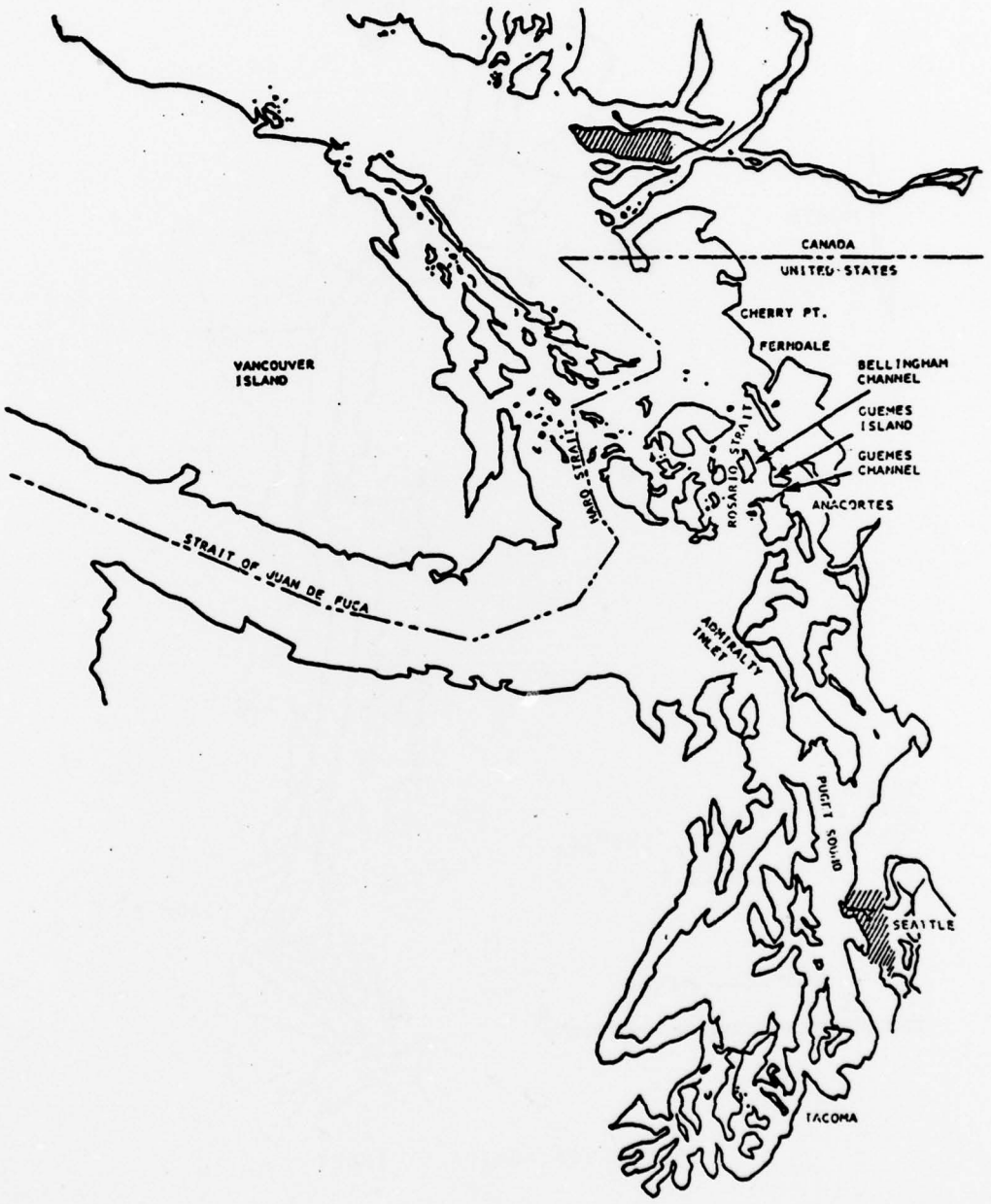
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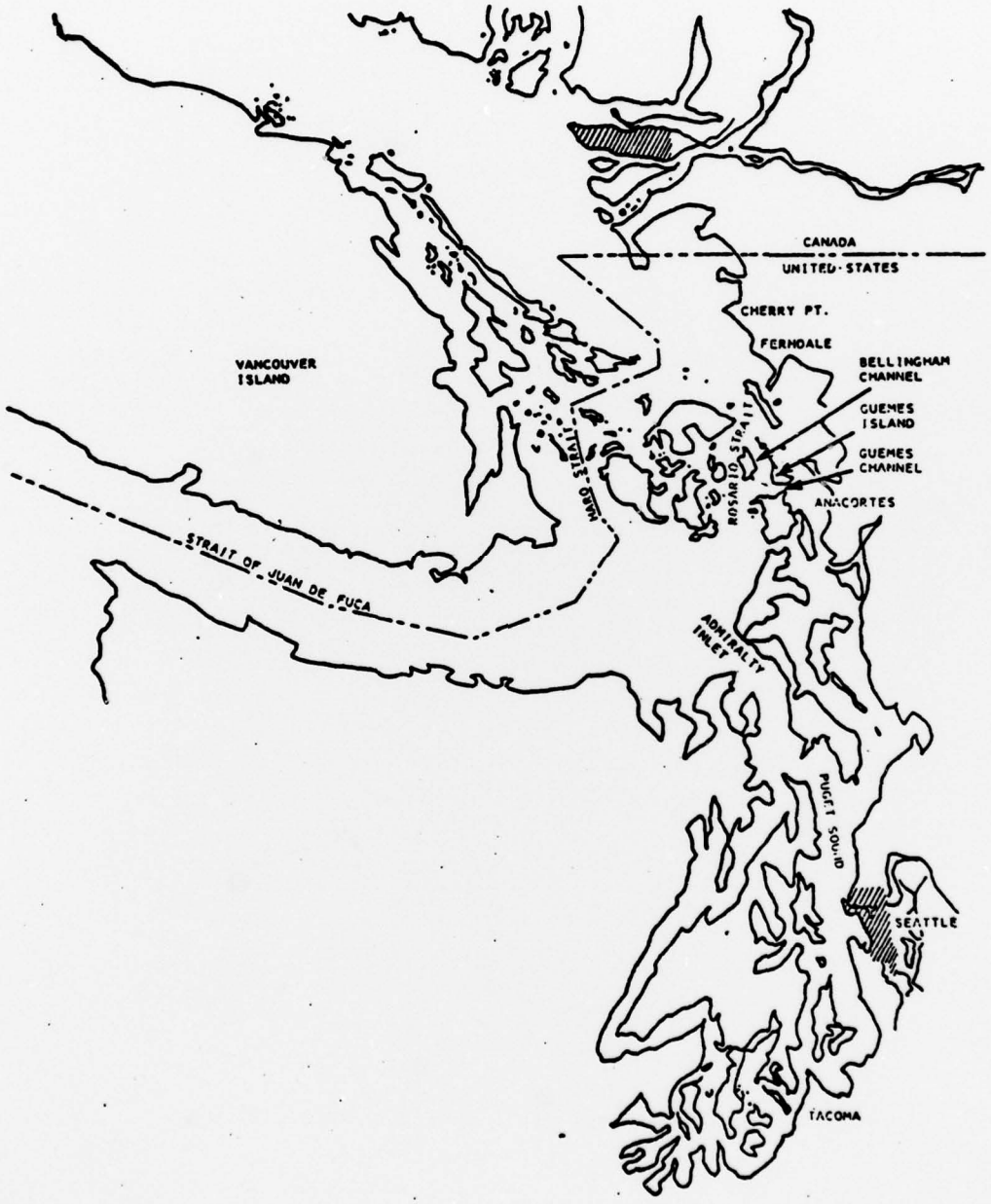
FERNDALE
BELLINGHAM CHANNEL
VANCOUVER ISLAND
GUEMES ISLAND
GUEMES CHANNEL
ROSARIO STRAIT
HARO STRAIT
ANACORTES
STRAIT OF JUAN DE FUCA
ADMIRALTY INLET
PUGET SOUND
SEATTLE
TACOMA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